THURSDAY, FEBRUARY 16, 1893.

QUALITATIVE CHEMICAL ANALYSIS.

Qualitative Analysis Tables and the Reactions of certain Organic Substances. By E. A. Letts, D.Sc., Ph.D., F.R.S.E., F.C.S., &c. (Belfast: Mayne and Boyd, 1892.)

THE author in his preface says, "Every teacher has his own methods—acquired not only from his experience, but also largely through the researches of others—and this book embodies mine." Therefore the volume cannot fail to be welcome to those who take an interest in the teaching of analytical chemistry. But it is surprising to find that Prof. Letts has until quite recently followed the old method of dictating reactions and methods to his students, and allowing them to work from their own notes. For the last fifteen years there has been no lack of text-books of qualitative analysis, and Prof. Letts has found, what probably all teachers of the subject are aware of, that students rarely take accurate notes. But, however exact they may be, every one knows that manuscript is not so easily deciphered nor so readily referred to as a printed page.

The methods of work given are, of course, more or less on the ordinary lines. The final test for bismuth depends upon the production of its black suboxide, and this reaction has much to recommend it, though probably many would prefer the oxychloride reaction. The use of ammonium molybdate as a separative reagent in qualitative analysis we do not consider advisable for many reasons, but no complaint can be lodged against it on the score of its accuracy.

There can be no doubt whatever that both Prof. Letts and his students will find considerable advantage in the use of boldly-printed statements of methods. But the author begins his preface by stating that although the book has been written chiefly for his own students, he will be glad if it prove of service to others also. This lays the volume open to general criticism, and prompts us to complain that it is neither so clear nor so systematic as it might have been. As to the want of clearness, there are a few expressions that can easily be altered in a second edition, and these we lay no particular stress upon. For example, at page 27, in the description of Bunsen's dry tests, we read:—"The charred end of the match is next moistened with fused carbonate of soda." At page 40 it states that the solution "is mixed with its own volume of chloride of ammonium." One assumes this to be a solution, but if so the strength of it is not given, and we fear that the bulk of the solution to which it is to be added will be likely to vary enormously according to the peculiarities of the student and the character of the substance he is at work upon.

The more important want of clearness may be exemplified by taking the case of a student who has Epsom salts given to him as a simple salt. This can hardly be called an out-of-the-way substance, but so far as we can discover, the student in following these tables would examine it by the following series of operations: Heating on platinum wire to see the colour of the flame. Heating on a borax bead in the outer and inner flames. Heating on a carbonate of soda bead. Heating on charcoal (if a white mass resulted, which with cobalt nitrate gave a "faint pink," the metal might be recognised here, but as magnesium sulphate does not readily yield this reaction in most cases the student would pass on). Heating on charcoal with sodium carbonate. Heating in a glass tube closed at one end. Repeating with bisulphate of potash. Repeating with black flux. Repeating with magnesium wire. He would then dissolve the substance in water, and test a part of the solution for ammonia by heating it with caustic alkali. Then heat a part on a platinum wire for the flame colouration, a test that has already been done on the solid, and then pass on to the examination of the solution in the ordinary way for the base, and finally search for the acid if it is not already found. It may be taken for granted that this fiddling about with the substance is not intended, but the volume does not appear to contain directions as to how to go more directly to work.

The want of system that we complain of is acknowledged by the author himself in picking out certain parts and labelling them as "systematic." If the whole were systematic this distinction would obviously be meaningless. As this fault exists in many of the text-books and in much of the teaching that we have had experience of, we are tempted to make a few general remarks upon the matter without special reference to the volume under notice.

That qualitative analysis is often regarded as a very unimportant branch of chemistry, may account for its comparative neglect. One constantly meets with students who are able to perform quantitative operations of not too complex a character with commendable accuracy, and that can with a little guidance do many sorts of "research work," but are wholly unable to perform with certainty a qualitative analysis of a comparatively simple substance. They may happen to find most or all of its constituents, but they have no confidence in their result; they do not feel sure that they have missed nothing, or indeed that everything they have found is unmistakably present, and generally they have little if any idea of the degree of accuracy of their work. They cannot distinguish between a principal constituent and one that is present in a comparatively small proportion. This incompetency must be ascribed very largely to the fact that students are too often urged on to work that a casual observer might regard as more important. The foundation is neglected for the sake of the superstructure.

But having regard only to that amount of practice in qualitative work that still remains possible for the average student, there is too often a lack of method that is surprising if not disastrous. As a rule, it is considered desirable to get first an idea of the general character of the substance given for examination by a few dry tests, but these, as often done, are not only of no use, but serve in a conspicuous manner to train the student in the making of careless and imperfect observations, and in the dodging about from one operation to another with no idea of the proper sequence or inter-dependence of the various parts of the work. In the analytical examination of even the simplest of substances, from the time when the student receives it until he has made his last note, every operation ought to be in an order for which very definite reasons can be given, and the completed work ought to be of such a character that anything added to it would be superfluous; anything taken from it would leave it imperfect; and any change in the order of its various parts would be to its detriment. This character of work is generally sought after in the separation of metals from a solution; but the rest of a qualitative analysis, namely the preliminary examination and the testing for acids, is too often a collection of odd operations, which, if the student is lucky, will lead him sooner or later to the desired result, but if he is unlucky may fail to do so through no fault of his own.

CHAPMAN JONES.

POPULAR LECTURES ON PHYSICAL SUBJECTS.

Gemeinverständliche Vorträge aus dem Gebeite der Physic. Von Prof. Dr. Leonhard Sohncke. (Jena: Gustav Fischer.)

IT is a matter of common remark that the books on scientific subjects which reach us from Germany are, as a rule, so special and detailed in character as to be totally devoid of interest, except to those immediately concerned with the subjects of which they treat. This being the case, it is all the more refreshing to meet with such a collection of popular addresses as Prof. Sohncke has gathered together in the volume before us. He has not restricted himself in his choice of subjects to any one branch of physics; on the contrary, the nine lectures of which the book is made up represent as many different divisions of natural philosophy, and were delivered quite independently before various audiences in Germany.

The first lecture of the series bears the somewhat obscure title, "What then?" and was suggested by a great strike among the coal-miners of Westphalia, which led to a temporary cessation of the German coal supply. The author depicts what would be the consequences if the world's coal supply were exhausted, in terms almost as pathetic as those of Prof. Jevons which moved an English Parliament to appoint a commission on the subject. But recognizing that, after all, coal is only stored up solar energy, Prof. Sohncke endeavours to look at the brighter side of the question by discussing the possibility of utilising the sun's energy in other forms, and so enabling man to remain "lord of creation" even in those days when the entire available coal supply of the world reposes on the shelves of some scientific museum.

Equally spontaneous is the lecture on "Migratory Mountains," in which an account of a holiday visit to the north-east corner of Germany gives an opportunity of describing the formation and movements of the mammoth sand-dunes in that locality.

Of the other lectures, that entitled "The revolution in our views concerning the nature of electrical actions" will probably commend itself to most readers because it treats of a subject now exciting general interest. It contains a short history of the arguments and experiments which led to the substitution of the ether theory of electrical action in the place of the older action-at-a-distance theories. While admitting the existence of a medium which transmits both optical and electrical disturbances, the author thinks it more probable that gravitation is a true action-at-a-distance, and in so doing he tacitly denies that a medium is a necessity. The notion of an empty space is so foreign to English men of science of this generation, that we certainly consider Prof. Sohncke's summing-up of the question to be worthy of attention. He says:—"Even if we could finally succeed in proving that action-at-a-distance is really the result of a transmission through some medium, we must not suppose that all difficulties are then removed. For the process of such a transmission is by no means simple, and cannot be explained without further assumptions; on the contrary, very formidable difficulties arise even here. Directly we try to give a concise explanation of the compression of a body and its subsequent expansion when performing elastic vibrations, we find that a choice must be made between two assumptions equally hard to accept. Either matter is itself capable of compression and expansion, or else it consists of separate vibrating atoms to which we must assign the property of exerting mutual forces on each other at a distance."

From a purely scientific standpoint, the lecture on "Newer theories of atmospheric electricity and thunderstorms" is undoubtedly the most valuable of the series, the subject being one on which Prof. Sohncke can speak with some authority. After describing the older theories of the origin of electrical charges in the atmosphere, he discusses those newer ones which were suggested by the discovery of Hertz that ultra-violet light facilitates the discharge of electricity from a charged body. Of these the best known is that of Arrhenius, who supposes the air, ordinarily a dielectric, to be rendered feebly-conducting by the action of light. According to this theory, the earth is negatively charged, and when its atmosphere is illuminated some of the charge is conducted away to the clouds. The conduction must be electrolytic, otherwise the air would become charged. Prof. Sohncke objects to this theory mainly on the ground that the discharging action of light cannot be considered as due to the air in any way, since it is manifested only when the light vibrations fall on, and are absorbed by, the negative electrode. Further, it is not easy to see how elementary gases such as oxygen and nitrogen can be electrolytes. In concluding he defends his own theory, according to which atmospheric electricity is produced when a cloud laden with particles of ice meets another charged with water drops, the electrification being due to the friction of ice against water. In support of his view the author quotes the fact that hailstones are found to be electrified on reaching the ground.

The appearance of a volume like the present one invariably gives rise to some regrets that the whole earth is no longer of one language and one speech, but we hope that some friend of popular science may be induced by the contents of the book to furnish a translation for English readers.

JAMES L. HOWARD.

BRITISH JURASSIC GASTEROPODA.

A Catalogue of British Jurassic Gasteropoda, comprising the Genera and Species hitherto described, with references to their Geological Distribution and to the Localities in which they have been found. By W. H. Hudleston, M.A., F.R.S., P.G.S., and Edward Wilson, F.G.S. 8vo, pp. xxxiv+147. (London: Dulau and Co., 1892.)

NEXT in importance to a monograph on any group of fossils is a catalogue of the species giving their distribution, their synonymy, and references to the figures and descriptions. The value of such a catalogue is enormously increased when, as in the present case, the authors have made a prolonged and careful study of the subject. The late Prof. John Morris was able, with scarcely any help from other workers, to publish a critical catalogue of all British fossils; the first edition appeared in 1843, the second in 1854. But since that date so much progress has been made in palæontology that the accomplishment of such a task by any one man would now be an impossibility. Prof. Morris always hoped to bring out a third edition of his work, and after his death a committee was formed to carry out this project. But the labour appears to have been too great and the committee soon ceased to exist. This is greatly to be regretted, for although the work must of necessity have been distributed among various authors, a certain amount of uniformity in treatment would at any rate have been secured and publication hastened.

In the preface we are told that Mr. Hudleston is mainly responsible for the Oolites and Mr. Wilson for the Lias. Under the term Jurassic the authors include everything from the Lias to the Portland-stone: the Rhætic beds, although not regarded as strictly Jurassic, are treated in the supplement. The total number of gasteropods recorded by Samuel Woodward from these formations in 1830 was only 89, whereas in the present work the number given is 1015. Of these 15 come from the Rhætic, 314 from the Lias, 681 from the Oolites, and 5 from the Lias and Oolites. In the Lias the gasteropods are characterized by the species belonging to comparatively few genera. Although, as far as genera are concerned, the Lias shows considerable affinity to the Oolites, there is nevertheless a great break in the continuity of the species, only five being common to the Lias and Oolites. Gasteropods are most abundant in the calcareous beds, so that the Lower Oolites have yielded by far the larger number of forms, the Inferior Oolite being richer than the Great Oolite. In the Middle and Upper Oolites there is a decided decline in the gasteropods, especially of the argillaceous beds.

After the introductory remarks the authors give a valuable bibliography of the British Jurassic Gasterpoda, and then a list of the genera, in which each is placed in its proper family and reference given to the original description. By the use of different type the genera are divided into four classes, (1) those fully accepted by the authors, (2) those accepted with doubt, (3) those given as Jurassic by other authors but not accepted, (4) synonyms. In the catalogue proper the authors have adopted Morris's plan, each page being divided into two columns; in the larger are given the name of the species, the references, the synonyms, and the cross-references; in the smaller the geological horizon and the more important localities, the locality first named being that from which the type was obtained or the first place from which the species was recorded in Britain. The dates of publications are often omitted, but since they can be found in the bibliography this is not very inconvenient except in the case of serials. The present *locale* of types is not given, although this would have been a comparatively easy matter, especially since so many catalogues of types have been recently published.

With regard to the orthography the authors have kept to the older and more usual method. For instance, the capital initial is used for species when derived from proper names, and the single *i* for the genitive is not always adopted. Thus we find a considerable variation in the terminations, such as, *Cricki* (p. 124) *Crickii* (p. 77), *Waltoni* (p. 42) *Waltonii* (p. 139), *Suessea* (p. 29) *Suessii* (p. 138), *Wrightii* (p. 46) *Wrightianus* (p. 70). These are, however, purely matters of opinion and do not in any way detract from the great value of the work, which exhibits so much painstaking accuracy and sound criticism.

H. WOODS.

OUR BOOK SHELF.

The Year-Book of the Imperial Institute of the United Kingdom, the Colonies, and India, and Statistical Record of the Resources and Trade of the Colonial and Indian Possessions of the British Empire. Compiled chiefly from official sources. First issue 1892. Issued under the authority of the Executive Council, and published by John Murray, &c. Large octavo pp. xvi. and 824.

THE Imperial Institute has lost no time in issuing a handsome and comprehensive year-book, compiled by the Librarian, Mr. J. R. FitzGerald, who has diligently and successfully gathered together a stack of varied information bearing on the purposes of the Institute. It is a question which time alone can answer whether amongst the many admirable year-books of statistics, commerce, and the colonies which have established themselves as annuals of proved utility, there is room for a new and bigger book overlapping their information, and containing few, if any, novel features. It would be out of place to discuss this question in a notice which ought to be confined to the scientific aspects of the work. The object of the year book, as expressed in the preface, is to deal "statistically with the physical geography, the natural resources, and the industries and commerce of the Colonies and India," and with certain other related facts. It would not be fair to criticise severely the first issue of so large and comprehensive a compilation; but it would help towards the attainment of the compiler's aim if the description of the physical geography of the regions touched upon could be made as full as the historical introductions, and as statistical as the commercial tables. More notice ought to be taken of the geology and the character of the soil in the colonies where geological surveys are in progress; and climate certainly deserves better treatment. We do not think space would be wasted in giving the mean monthly temperatures and rainfall for the average year, and for two extreme years, at a few representative stations in the larger colonies. This information cannot indeed be found in any existing books, but must be worked out from original records which exist abundantly, and are rarely made available to practical workers.

The treatment of natural resources might also be improved by a firmer grasp of scientific principles. The commercial statistics are, as might be expected, much fuller, better arranged, and more serviceable than those relating to physical geography; but we imagine that few members of the Imperial Institute, likely to make use of the book, are without the original records relating to their own department. The difficulty of proportion and perspective is rather seriously apparent in the treatment of India, which has to be passed over more lightly than the colonies, because equal detail would involve the sacrifice of much space. Thus the great internal trade of India is scarcely touched upon, and the wants and tastes of consumers in the ultimate Indian market, by whom imports are finally absorbed, are not laid before the British merchant.

Beneath Helvellyn's Shade. By Samuel Barber. (London: Elliot Stock, 1892.)

THIS book consists of notes and sketches in the Valley of Wythburn, and is brightly and attractively written. Perhaps the best chapters are those on clouds, the various forms of which have been carefully studied by the author. He has also many interesting remarks on various aspects of Cumberland scenery, on the customs of the people, and on antiquities. Occasionally, perhaps, Mr. Barber adopts too much the tone of a preacher, but his impressions and ideas are for the most part fresh and vivid. The book will especially please those who have themselves felt the charm of Wordsworth's country.

LETTERS TO THE EDITOR.

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

Dr. Joule's Thermometers.

RESPECTING the question asked by Mr. Young (NATURE, vol. xlvii. p. 317), I am glad to have an opportunity of stating that shortly after Joule's death I obtained the sanction of his son to examine the scientific apparatus that were left in his house.

I found a number of thermometers, and amongst them the two chiefly used by Joule in his researches. These thermometers have been placed in my charge for the present. I have made careful comparisons of them with a standard of the "Bureau international des Poids et Mesures," and therefore indirectly with the air or hydrogen thermometer. A standard issued by the Technische Reichsanstalt has also been used as a check. I spent a good part of last winter on the work and am now only waiting for an opportunity to repeat some of the measurements. The results will be published in due course, and I think will prove of interest. As Joule compared his thermometers with one used by Rowland, we shall in this way have an indirect comparison of Rowland's air thermometer with those by which the Berlin and Paris standards have been independently fixed.

One question arises on which I should be glad to have some information, and I should be grateful to any of your readers who could help me. The glass of which Joule's thermometer is made does not behave like the English glass now in use; and it would be important to know the probable composition of glass used in England about the year 1840 for thermometric purposes. As my experiments are not concluded I do not wish to speak with too great a certainty; but I believe it will be found that if we could return to the glass of Joule's thermometer, we should have a substance as well and possibly even better adapted to the manufacture of thermometers than the modern Jena or French thermometer glass.

I am sorry I cannot give a very definite answer to Mr. Young's question. Joule does not, as far as I know, anywhere give the actual readings of the freezing point, but only its changes. Rowland, in quoting the comparison between Joule's thermometer and his own, gives 22·62 as the actual reading of Joule's zero. I have not at the present moment access to Rowland's paper, and have no note of the date at which this comparison was made (either 1879 or 1880).

Such a formula as that given by Mr. Young can, however, only have a limited application. The zero of a thermometer depends on the temperature at which the thermometer has been kept previous to its immersion into ice, and with properly-annealed thermometers the secular changes are much smaller than the temporary ones. Last winter Joule's thermometer showed changes in zero from 23·51 to 23·00 on the arbitrary scale, the original temperatures varying from 7° to 30°.

All observations lead to the conclusion that the secular changes of a thermometer gradually vanish, so that the zero corresponding to any temperature approaches a limit. Mr. Young's formula would make the zero rise indefinitely.

ARTHUR SCHUSTER.

Dust Photographs and Breath Figures.

YOUR two correspondents on February 9 add interesting instances of these phenomena. I am sorry that one of my statements was not clear. In saying "Two cases have been reported to me where blinds with embossed letters have left a latent image on the window *near* which they lay," I meant to describe them as not in contact.

I have questioned my neighbour Dr. Earle again as to his case. The plate-glass window of an hotel in London has on the inside a screen of ground glass lying near but not touching: upon the latter are the words "Coffee Room" in clear unfrosted letters. One day as he was at breakfast the screen was taken away, but the words were left plainly visible on the window, and no washing would remove them. The other case is curiously similar, but each narrator was ignorant of the other's tale. A friend, Mr. Potter, asked me if I knew whether a house in which he was lodging had been an hotel, for on misty days they saw "Coffee Room" on one of the windows. I remembered the house had been an hotel two or three years previously, and there had been brown gauze blinds with gilt letters.

Mr. Thiselton-Dyer's observation appears not so much akin to these two as to the dust picture of a water-colour drawing of which I spoke in my former paper.

I look forward to seeing the effects at Canterbury.

Winchester College, February 13. W. B. CROFT.

Fossil Plants as Tests of Climate.

MR. DE RANCE'S note relating to the above subject in NATURE, p. 294, mentions that "Heer has determined a magnificent flora of more than 350 species from these northern tertiaries, and that he at once pointed out the absence of tropical and subtropical forms." My contention, founded on an attentive study of his determinations and of the original specimens in London and Dublin, and to some extent in Copenhagen, is that not fifty, or perhaps not the half of fifty, of these determinations are entitled to the smallest weight; and again that though at first he saw nothing subtropical in the flora, he subsequently declared the presence of palms, &c., upon utterly insufficient data. While, however, wishing to rid the "magnificent" flora of 300 or more useless and misleading encumbrances, I am far from wishing to depreciate the extraordinary significance and value of that which remains, and which clearly shows that in early Eocene times the coast of Greenland supported in certain places forests which included the redwood, the plane, and even the magnolia, associated with many more northern forms. This is consistent with the tropical vegetation existing during a part of the possibly contemporary lower tertiary period in the south of England. Both facts are sufficiently inexplicable, but there is no occasion to magnify the difficulties they present. As to the Greenland floras they have not been proved to contain any forest trees that might not, and which in fact do not, flourish in their modern representatives, when planted in certain favourable spots on the west coast of Ireland, and even of Scotland. We are not even obliged to assume that Greenland as a country was characterised by such vegetation, for this might be as erroneous as to regard Ireland or Scotland as countries generally characterised by forests of arbutus. The flora of a country is in fact most likely to be preserved in its most sheltered spots, in lake bottoms like parts of Killarney, or where small rivers quietly steal into the tidal waters of deeply recessed bays like those of Bantry and Kenmare, in forest pools like some in the Mount Stewarts' woods of Bute, and in the backwaters and marginal pools of the lower reaches of larger rivers; we are not only entitled, but we are bound to consider this to have been the case in Greenland, and to base our estimate of its climate in the lower tertiaries upon this view and no other. Now what geologists and physicists ought to do, and what they resolutely won't do, is before going farther afield for cause and effect, to take the map of the world on Mercator's projection, and consider how far, if the Atlantic were a closed ocean to the north, as we know it must have been, the required climatic conditions would be produced. The difference between the arbutus nooks of Ireland on the one side and the desolation of Labrador on the other is brought about solely by ocean currents. At the period of the Greenland floras the arctic currents were excluded, and consequently the whole Atlantic basin was filled with the circulation of equatorial and temperate waters only. The distribution of plants and animals renders it extremely probable that during much of the tertiary period, the antarctic waters were equally excluded from the Atlantic by land connecting Africa and South America. What, under these circumstances, would happen to the climate of the Atlantic littoral? It would, it appears to me, be more philosophical to dispose of this question, which is supported by a weight of evidence, before invoking shifting of the earth's axis, or other hypothetical causes supported by none. J. STARKIE GARDNER.

London, February 13.

An Optical Phenomenon.

IN NATURE, vol. xlvii. p. 303, you mention that "a beautiful optical phenomenon, which has not yet been satisfactorily explained, is described by M. F. Folie in the *Bulletin* of the Belgian Academy." From what follows, it is evidently the same as that described in Tyndall's "Glaciers of the Alps" (Murray, 1860), p. 177 *et seq.* Tyndall gives a description of it in a letter from Prof. Necker to Sir David Brewster, from which I quote the following:—"You must conceive the observer placed at the foot of a hill between him and the place where the sun is rising, and thus entirely in the shade; the upper margin of the mountain is covered with woods, or detached trees and shrubs, which are projected as dark objects on a very bright and clear sky, except at the very place where the sun is just going to rise; for there all the trees and shrubs bordering the margin are of a pure and brilliant white, appearing extremely bright and luminous, although projected on a most brilliant and luminous sky. You would fancy you saw these trees made of the purest silver."

Prof. Necker says that he saw it at the Saleve, which is not so high above the Lake of Geneva as some of our British mountains above the sea, and has no permanent snow near it; so that M. Folie's suggestion, that it is due to light reflected from snow, must be wrong. I have seen it from the König-See, near which I believe there is no permanent snow.

This appearance is always to be seen under the circumstances described, when the sky is clear and bright enough. I had read of it in Tyndall's book, and when in the Alps I sought for and found it. I have often seen a distant approach to it produced by furze bushes, quite near, seen against sunlight, and by leaves against moonlight. JOSEPH JOHN MURPHY.

P.S.—Ruskin somewhere describes this phenomenon.

Belfast, February 6.

Foraminifer or Sponge?

A PAPER by A. Goës "On a peculiar type of Arenaceous Foraminifer from the American tropical Pacific, *Neusina Agassizi*," has just been published in the "Bulletin of the Museum of Comp. Zoology, at Harvard College," vol. xxiii. No. 5, in which the author describes some remarkable forms dredged by the *Albatross* expedition in the Pacific of Central America. They are supposed to be foraminifera, are of leaf-like shape, measure up to 190 mm. in breadth, and are marked by concentric lines of growth. Their interior shows a stroma, consisting of fine chitinous threads, enclosing sand and *débris* of shells. Without wishing to recapitulate all the various points of structure, I will only say that there can be no doubt that these forms belong to Hæckel's deep sea keratosa (see *Challenger* report, vol. xxxii.) from the tropical Pacific, and I should think that *Neusina Agassizi* is identical with *Stannophyllum zonarium*, Hæckel. I happen to have here a *Challenger* specimen of this latter species, kindly lent to me by the Manchester Museum, and its microscopic examination convinces me of the identity of the two forms.

University College, Liverpool. R. HANITSCH.

Unusual Origin of Arteries in the Rabbit.

TOWARDS the close of last month Prof. W. N. Parker reported in your columns an abnormality in the veins of the rabbit, and although the same interest does not attach to it, it may be worth while recording an unusual arrangement of the vessels arising from the aortic arch. In the case which has just come under my notice, the two carotids arise together from the arch, at the point usually occupied by the innominate artery, while the right subclavian artery arises beside the left subclavian, which occupies the usual position. PHILIP J. WHITE.

University College of North Wales, February 7.

Holmes's Comet.

ON February 11, 10h. to 10h. 35m., I re-observed this object with powers of 40 and 60 on my newly-silvered 10-inch reflector. The comet was in the same field as β Trianguli and south preceding that star. I found it fairly conspicuous. The nucleus, or brighter portion of the head, presented a distinctly granulated appearance. Applying a power of 145, single lens, I saw that it really consisted of a number of very small knots of nebulosity, so closely approximating the stellar form that they might readily have been mistaken for one of the very faint, barely resolvable clusters in which the components are only to be caught by glimpses. The multiple nucleus was involved and surrounded with feeble nebulosity, and a faint tapering tail flowed from it in a N.E. direction. I believe that outlying this there was an excessively faint fan-shaped tail, but could not be absolutely certain.

The sky was not good, being lighter than usual, with suffused mist. On February 12, at 10h. 15m., I picked up the comet again, but details were invisible, owing to the veil of thin cloud overspreading the N.W. sky at the time.

Bristol, February 13. W. F. DENNING.

HELMHOLTZ ON HERING'S THEORY OF COLOUR.

THE following translation of the critical account given by von Helmholtz of the colour-theory of E. Hering, in the new edition of his *Handbuch der Physiologischen Optik*, commencing at page 376, has been made by Prof. Everett for NATURE. The translator aims at clearness rather than literal rendering, and three obvious misprints in the paragraph on the transformation of coordinates have been corrected. "Lambert's colour-pyramid" is another name for the "cone of colour" described in Maxwell's papers and in § 1074 of Everett's "Deschanel."

This much-talked-of theory is a modification of Young's theory, which, by the choice of other fundamental sensations, endeavours to give better explanations of what it regards as immediate facts of internal observation. It assumes three elementary sensations, related to three different parts of the nerve-apparatus or "visual substance." Two at least of these physiological processes exhibit the opposition of positive and negative. One of the three "visual substances" gives in the condition of excitement the sensation of white, and in the condition of rest the sensation of black. The second gives the two sensations of blue and yellow, which are accordingly designated "opposed colour-sensations." The third gives the other pair of "opposed colour-sensations," red and green. But by "red" is denoted not the colour usually so called, but the complementary of green, which is purple.

It is possible to specify "elementary sensations" (in the sense in which we have previously defined the term) which would correspond to Hering's elementary sensations, and would be capable of giving by their combination all other colour-sensations. If we take three rectangular axes of coordinates, x, y, z, as the edges of Lambert's colour-pyramid, x corresponding to red, y to green, and

z to violet, Hering's coordinates u, v, w will have the values

$$u = \frac{x + y + z}{\sqrt{3}}, \quad v = \frac{x - z}{\sqrt{2}}, \quad w = \frac{x - 2y + z}{\sqrt{6}}$$

u denoting the white element, and being measured along the axis of the pyramid; w denoting the red-green element, and being measured at right angles to the axis of white, in the plane containing the green edge of the pyramid; v denoting the yellow-blue element, and being measured at right angles to the plane of u, w.

Positive values of w correspond to purple red, and negative values to green. Positive values of v correspond to yellow, and negative values to blue.

I give these equations in this definite shape for the purpose of showing, by a definite system of representation, that the arbitrariness which attends the choice of three colours, in terms of which the rest are to be specified, affords sufficient latitude to admit of the employment of three such different specifying elements as are adopted by Hering.

If only positive values of x, y, z are to be admissible, the expression for u shows that every kind of light must excite the white sensation positively, and consequently that no kind of objective light can produce a pure sensation either of the red-green or of the yellow-blue kind. Hence the pure unmixed "opposed colour-sensations" are such as we never have had or can have, and are separated from all colour-sensations that we have ever had by a much wider gap than the pure sensations which Young's theory supposes, although these latter extend somewhat beyond the range of objective colours. By subjecting portions of the retina to special influences (as we shall explain in treating of after-images) we can at least approximate to Young's elementary sensations; while these same methods, when we attempt to approximate to Hering's pure sensations, give results opposite to what his theory would lead us to expect.

Hering assumes, in accordance with the brief expression of his theory in the above equations, that white light excites only the white-black visual substance and excites it always positively; that yellow light, besides doing this, excites the blue-yellow visual substance, as does also blue light, but in opposite sense. On the other hand, when blue and yellow lights are in exact equilibrium, they have no action on the blue-yellow visual substance.[1] Similar remarks apply to the excitements of the red-green visual substance by red and green light.

The sensation of luminosity is identified by Hering with the sensation of white. He accordingly maintains that the pure sensation of blue or of yellow involves no sensation of luminosity. I must confess that personally I can form no conception of a colour which has no degree of less or greater luminosity, and therefore think such an abstraction not tolerable in a system which, on other points, makes its appeal to the immediate testimony of inner consciousness, and claims by this means to establish its superiority to other systems.

Differences of intensity must, however, occur in the opposed colour-sensations if they involve no difference of brightness. In comparing saturated blue with equally luminous pale blue, Hering would regard the white sensation as equally intense in both, but the blue sensation as stronger in the saturated blue.

As the physiological basis of the "opposed colour-sensations" Hering takes the two opposite processes of organic change, namely, the decomposition of the organic mass by activity, and its restoration under the influence of the circulation of the blood, which carries oxygen stored up in it and feebly united with it. The former process is called *dissimilation*, and the latter *assimilation*. Which of the two opposed sensations corresponds to dissimilation and which to assimilation is left undecided, both in the case of blue-yellow and of red-green. The physiological improbabilities of this assumption have in part been pointed out already, and we shall return to the subject in treating of after-images.

This assumption of double nerve-working was originally applied by Hering to the white-black visual substance also. At the present time he adheres to the hitherto-received doctrines of nerve-physiology to the extent of holding that, in the case of this substance, all light excites only dissimilation and the sensation of white; and on the other hand want of light produces only assimilation and restoration of excitability. That during this latter process a sensation of darkness is experienced, all are agreed. The difference is purely theoretical. According to the older view, which I have defended, we must, in order to perceive that there is luminosity in a particular part of the field of view at a given time, be able to distinguish at another time that this perception is wanting. This perception that a sensation which might be there is not there contains in itself a testimony as to the condition of the organ at the time, which is different from all sensations of incident light; and in this sense we call it also a sensation—the sensation of darkness.

Hering, on the contrary, maintains that the sensation of black must have its own special physiological basis of excitation, and seeks it in assimilation, going on in the white-black visual substance.

From the foregoing account the reader will gather that Hering's theory, if we overlook its physiological views, is able to explain all hitherto established facts of colour mixture as well as, but not better than, Young's theory. It differs only in its special choice of elementary excitations; and this choice, if we admit negative values of them, suffices for expressing the facts, just as any axes of co-ordinates suffice for a problem of solid geometry.

Hering's objections to Young's theory reduce themselves, in his latest statement, to the following:—

"In the Young-Helmholtz theory, the assumption of the three elementary colour-sensations is *à priori* repulsive, because these sensations are not presentable; and notoriously, according to necessity, now one set and now another set of elementary colour-sensations are assumed."

As to this, I have already remarked that the fundamental sensations of Young's theory, in so far as they differ from objective colours, can be approximated to, by the method of partial fatigue of the retina, much more closely than Hering's pure opposed-colour-sensations. If different upholders of Young's theory have made different assumptions as to the three primary colours, and have assigned different weights to various facts which bear on the distinction, this affords no justification whatever for the imputation that they have changed their assumptions according to necessity. It is always better to acknowledge existing doubt than to dogmatise.

Hering goes on, "If the excitations belonging to the three elements have correspondingly distinct physiological causes, one would expect that these sensations would have something special about them."

This they have, in my opinion, in the prominent glow of colour-saturation; for which, again, the theory of opposed-colours furnishes no basis of explanation.

He continues, "Yellow gives, for example, much more the impression of a simple or elementary sensation than violet, and yet we are told that the latter is an elementary sensation and the former a mixture of simultaneous sensations of red and green, or at least, in some way, the product of the simultaneous existence of the principal excitations corresponding to these two elementary sensations."

What a deceitful test apparent inner consciousness is in such matters, we can see from the examples of two

[1] This was a point which Hering left doubtful in the earlier statements of his system, so that it was not clear whether he assumed three or six independent variables. According to his more recent explanations the statement given in the text may fairly be said to represent his view.

such authorities as Goethe and Brewster, both of whom believed that they saw in green the blue and yellow, of which, being misled by experience with pigments, they believed it to be composed.

He goes on, "Helmholtz says, quite correctly, 'so far as I see, no way has been found of determining one of the elementary colours except the investigation of colour blindness.' This investigation has notoriously not confirmed Young's theory."

This would, even if it were true, be in itself no argument against the admissibility of the theory. The theory of colour-blindness seems, as we shall shortly see, to be a particularly hard crux for Hering's theory; while the hitherto well-established facts of red-blindness and green-blindness admit of comparatively easy and perfect explanation by Young's theory.

He adds, "And the three sets of fibres, which, however, as Helmholtz remarks, are not essential to the theory, have hitherto been sought for in vain."

This objection applies to Hering's theory as much as to Young's.

The reader will easily convince himself that these objections are of no weight whatever. He follows them up by an enumeration of contradictions and inaccuracies which he professes to have found in Grassmann's and my own explanation of Newton's law of colour-mixture, and partly also in that of Kries, errors which, even if they existed, would in no way tell against Young's theory, but only against its interpreters. Here, however, the obscurity seems to me to lie on the side of our opponent.

These objections arise out of the fact that, in mixtures of a saturated colour with white, the tint of the mixture sometimes seems changed (pale red for example approaches more to rose, and pale blue to violet); and that, on the other hand, with increase of intensity, the colours of the spectrum appear sometimes paler, sometimes yellower. But if we speak of those elementary excitations which, from the point of view of Newton's law, are alone entitled with certainty to the name of elements, as being able to coexist without mutual disturbance, then the only sensation which can with certainty be regarded as corresponding to the coexistence of a white and a red elementary sensation is that which comes into existence under the simultaneous influence of the corresponding white and red lights. The term "elementary sensation" is in this connection to be taken, of course, not in the narrow sense of Young's hypothesis, but in the wider sense above explained—the sense in which we speak of linear relations between colour-sensations and linear superposition of elementary-sensations. In the domain of colour-mixture we know nothing of any elements but these superposable ones; and if we would preserve a constant meaning for our colour-equations we must interpret them in this sense, as I have explained above. This is what H. Grassmann and myself have always done.

Moreover, erroneous estimates of the difference between a pale and a more saturated colour are liable to be made, and hence those colours which are really most diluted with white do not always appear the palest. If, without sufficient experience of colour-mixture, we only guide our judgments by similarity of sensations, we are liable to make mistakes as to which colour contains white. The question of the power of perceiving differences will therefore arise. Further, it is found that colours of very strong luminosity do not differ so much from one another in the sensations they produce as colours of moderate luminosity,—a fact which finds its explanation in Young's theory, of which it is a natural consequence. Colours when highly luminous appear more similar to one another and more similar to white. We express this by calling them pale as compared with colours of feebler luminosity. I have, however, already mentioned that the law of superposability ceases to be applicable when the luminosity is excessive.

Nevertheless, in view of the fact that simple colours of high luminosity are always as saturated as colours of such luminosity can be, it is not necessary, or rather it is not correct, to designate them as less saturated. The true statement is that differences of tint become more uncertain at high intensity—an uncertainty, which attaches also to the estimation of the intensity itself, as has long been known.

If Hering's sensation of white and opposed-colour-sensations are truly to deserve the name of elements or constituent parts of sensation (as he plainly intends, since he assigns to them special visual-substances), either he must acknowledge them as the elements deducible from the law of addition, or else they are purely hypothetical processes of whose existence and superposability no one knows anything. His polemic against Grassmann and me then amounts to this—that at a time when his hypothesis had not been propounded we did not speak in the sense of it.

Hering seems to regard as the chief point of superiority of his own hypothesis its closer conformity with the names which have established themselves in language—names which, as I have explained above, relate rather to the colours of material bodies than to the colours of light. To this circumstance it is, in fact, indebted for a certain amount of popularity and facility of apprehension. He himself assumes that these names have sprung from an immediate perception of the simple elements of sensation by a kind of inner consciousness, and thinks that he has thus very certain and immediate knowledge of the pure red-sensation, the pure white-sensation, and so on.

In his publication of 1887 he has discussed the possibility of assuming, instead of three or six simple processes of sensation, a larger and perhaps indefinitely great number, and a corresponding number of "elementary powers" for the several kinds of objective light. He, however, gives the geometrical representations of such actions in such a manner that practically these powers all depend on three independent variables. On the other hand, as regards these independent variables, which are the most important factors in the problem, he gives as good as no clue to them; he only seeks to remove them as far as possible from the sphere of physiology. For my own part I am able to understand this whole series of descriptions only as meaning that an arbitrary number of visual substances can be assumed to exist in the brain, and that their respective strengths of excitation are different functions of the same three independent variables, each visual substance being unaffected by the excitations of the rest, and the excitation of each being susceptible of direct apprehension in consciousness. I do not think it is necessary, in this book, to go further into such hypothetical views.

Hering especially claims the credit of opening up the way to understanding colour-blindness. He makes all dichromasy depend upon a single cause, namely want of sensibility in the red-green visual-substance. The difference between red-blindness and green-blindness is, according to him, attributable to different colourations of the media of the eye; partly of the yellow spot of the retina, partly of the crystalline lens.

These colourations are chiefly met with in the sick or the very old, and, when occurring in otherwise useful eyes, are not of such strength that they could bring out conspicuous deficiency of brightness in different parts of the spectrum.

The colouration of the yellow spot of the retina takes effect in a very limited but very important part of the field of view, and in only a narrow band of the spectrum. The most trustworthy observations on the influence of the wave-length of the incident light upon the strength of the red and green excitations, have been made with kinds of light not liable to be absorbed in notable degree by the yellow pigment. On the whole, it is accordingly found that this pigmentation is subjectively influential only in cases in which the rays in the neighbourhood of the line F play a prominent part, as, for example, in a certain mixture of this blue with red (mentioned on page 354) which, if it looks white when our eyes are directly fixed upon it, will show blue predominant when we look in a slightly different direction.

As far as hitherto-known facts go, it appears very improbable that Hering's theory of dichromasy can be carried through. Nevertheless, further observations in this direction are very desirable. The influence which the colouration of the yellow spot has in individual eyes can be estimated by comparing the appearances of colour-mixtures in the centre of the field of view with their appearances very near the centre. Such comparisons will show with certainty where such influence is present and where it is absent.

The following is a summary, by Prof. Everett, of two passages from the new edition of Helmholtz's "Physiological Optics," which are important as supplementing the foregoing critique of Hering's theory:—

In discussing the results of experiments for determining the exact positions of the three elementary sensations with respect to actual colours, in Newton's diagram or in Lambert's pyramid, Helmholtz represents the results by a triangle with the three elementary sensations at its corners, and with the colours of the spectrum plotted along a curve which lies entirely in the central portion of the triangle. He says, p. 457:—

"This curve shows that every simple colour excites simultaneously in the trichromic eye the three nerve-elements which are sensitive to light, and excites them with only moderate differences of intensity. If we then hypothetically refer all these excitations to the presence of three photo-chemically alterable substances in the retina, we must conclude that all three of these must have nearly the same limits of sensibility to light, and must show, in the rates of their photo-chemical actions for the different wave-lengths, only secondary variations of moderate amount. Similar variations, arising from the presence of foreign substances, from substitutions of analogous atom-groups, and so on, occur also in other photo-chemically alterable substances as used in photography; for example, in the different haloid salts of silver."

In a mathematical discussion of colour-blindness, commencing at p. 458, he points out that in dichromic vision there must be a linear relation between the three independent elements of trichromic vision, and in Lambert's colour pyramid there must be a certain line through the vertex, such that any plane drawn through it is a plane of uniform colour. Newton's diagram of colour may be regarded as contained in any plane which cuts the axis of the pyramid; and it is very important to determine the point in which the above-mentioned line cuts such a plane; for any line in Newton's diagram that passes through this point is a line of uniform colour to the dichromic vision in question. Experiment shows that it always lies outside the triangle of actual presentable colours.

Addendum.

Prof. Everett adds the following remarks of his own on the present position of the problem of colour-vision:—

On the one hand, it is established, as a fact of experiment, that the excitation of colour-sensation in the normal eye depends upon only three variables, and that their effects are superposable, so as to admit of being expressed by equations of the first degree, otherwise called linear equations. The simplest choice of three variables is that adopted in Young's theory, because it only requires positive values of the variables.

On the other hand, the various colours regarded as subjective appearances do not naturally class themselves under a threefold heading. Yellow does not look as if it consisted of red and green. Colour-sensations as known to us in consciousness are not threefold but manifold.

The two facts taken together seem to imply two successive operations intervening between the incidence of light and the perception of colour. The first operation is threefold, and may consist (as above suggested by Helmholtz) of the photo-chemical decomposition of three different substances. The second operation consists in the effects of the first operation upon a complex organism, and the distinctions of colours as we see them arise out of the nature of this organism.

The number of independent variables required for specifying the condition of a system is a very different thing from the number of well-distinguished states in which the system can exist. For example, the state of a given mass of water-substance is completely determined if its volume and temperature are given, and therefore depends on only two variables. But the number of its well-distinguished states is three. In like manner colour depends on three variables, but the number of well-distinguished colours, besides white, may be said to be seven, namely the six principal colours of the spectrum and purple.

What differences of condition in the organism correspond to these eight distinct appearances in the field of view, and how these different conditions are produced by the three primary excitations, are problems awaiting solution.

AUTOMATIC MERCURIAL AIR-PUMPS.

Of late years, and more especially during the last decade, men of science have devoted much thought and ceaseless energy to the invention of an apparatus which should admit of the automatic working of mercurial air-pumps. Of the numerous inventions brought forward, the ingenious apparatus of Schuller and Stearn are especially deserving of mention.

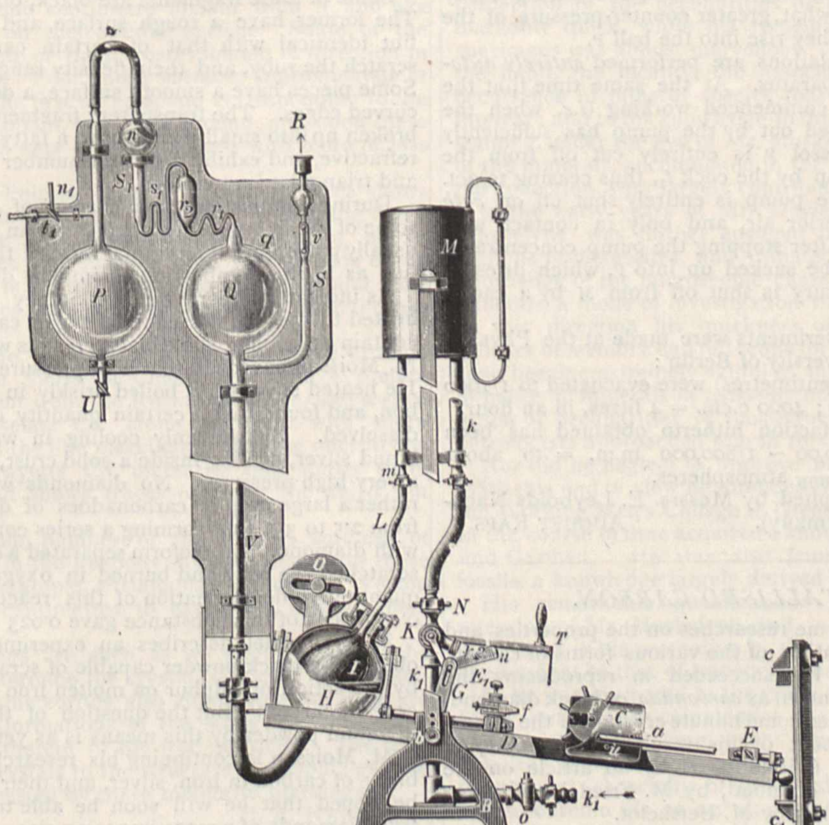
But notwithstanding the present extensive employment of the mercurial air-pump in science as well as in technics these appliances are neither much known, nor have they been used to any great extent, although they are of great importance, and would probably be very advantageous. This may be explained by the fact that they are wanting in the necessary simplicity and trustworthiness, without which the advantages of automatically working mercurial air-pumps are somewhat doubtful.

We shall describe now an apparatus for the perfectly trustworthy and automatic working of mercurial air-pumps, as well as the shape of the glass pump used in connection with it, which, while possessing the greatest possible simplicity, admits of the highest rarefactions hitherto known.

The figure shows the automatic apparatus in connection with an improved Toepler mercurial air-pump. The glass ball H is connected on the one hand by flexible tubes with the pump Q, on the other hand by the tube L with the accumulator M. The water-pipe K runs into the bottom of the accumulator, and by means of a specially-constructed three-way cock K can either be connected with the hydrostatic pressure-pipe K_1 or the discharge-pipe K_2.

If water under pressure is admitted through the tubes k_1, K and k into M, the air contained in M is compressed. This air again exerts a pressure through the tube L on the mercury contained in H, and drives it into the pump Q. As soon as the mercury has risen sufficiently high and the cock K is reversed, the compressed air forces the water out again through k, K, and k_2, and the mercury falls down on account of its own weight out of the pump Q back into the ball H.

The reversing of the three-way cock, and therewith the automatic action of the pump, is effected in the following manner:—The ball H rests on a frame D, revolving about the axis *b*, and the motion of which is limited by the ledges *c* and c_1. A lever G is attached to the frame not far from the axis, and by means of a peg, when the balance D reverses its position, also turns the cock. When the ball H is entirely filled with mercury the balance D rests on the upper ledge *c*. If the pump is set in motion the left side of the balance D becomes lighter in proportion to the amount of mercury forced out of the ball H into the pump, until at last the weight C on the right-hand side becomes heavier, and the balance thereby attains the position shown by the figure. The three-way cock is also reversed by this motion.



Thus, as already described, the water current is now cut off, the water present in M flows out through K_2, and the mercury goes back from the pump Q into the ball H.

During the tipping over of the balance, however, the sliding weight C has run down its inclined plane to a ledge, E, so that it now exerts a pressure on the lever arm. Its momentum is so calculated that the mercury in the pump must have fallen to the point *p*, and flowed back into the ball H before it again overweighted, and moves back the balance. The weight C then slides back again to the left until it rests against its left ledge, and the play of the pump recommences. It will easily be seen that the height to which the mercury rises in the pump, the mass of the sliding weight being a constant quantity, depends only on its final positions, and that, therefore, the adjusting of the height of the mercury can be easily and accurately done up to a centimetre.

It goes without saying that every mercurial air-pump not provided with cocks can be worked by the apparatus just described. But the improved construction of the Toepler pump, drawn likewise in projection in the figure, has proved to be especially practical. The following is a description of its automatic working:—

If the cock t_1 is connected with an hydrostatic air-pump, the ball Q of the pump and the space R, which is to be evacuated through the tube S, is pumped out up to the tension of the vapour. The mercury then rises in the tube R almost to the height of the barometer above its level in the ball H. If the automatic apparatus is then set in motion, the mercury enters the ball Q and the tube S, thus cutting off the connection with R, while any further rising of the mercury in the tube S is prevented by a glass valve *v*, it passes through the first V-tube r_1 filling the little vessel r_2 and rises through s_1 into the ball *n*, driving before it the air which was before shut off in Q. At this moment so much mercury has been forced out of the ball H into the pump Q, that the balance is turned, the mercury flows back out of Q into H, forming vacua in r_2 and Q, as the little mercury-threads remaining in the side-tubes r_1 and s_1 form shut-off valves. As soon as the mercury has fallen below the entrance-point of S into E the pressure in R and Q become equal, the denser air flowing out through S into Q. The time during which Q is connected with R may be determined at will by changing the right ledge of the sliding weight. Then the balance again changes its position, the mercury rises in

V, and so on. When the pump has made a few strokes in this manner, a lever T is let down, so as to rest on the ledge *u*. The wheel F provided with six pegs is now turned a tooth farther each time the weight C slides from the left to the right, and the ledge-peg *f*, which when the lever was raised caught each time into a notch of the peg-wheel, rests for the length of five strokes of the pump against the circumference of the wheel, and does not catch into the notch until the sixth stroke. As the rising of the quicksilver in the pump is in the inverse proportion of the momentum of the counter-weight in its left final position, if the ledges and peg *f* are rightly placed, it will when ascending be driven five times into the little hollow space r_2 and only at the sixth into the ball *n*. In consequence of this the little air-bubbles are accumulated in the highly evacuated space r_1 in which they ascend owing to the slight counter-pressure, and forming larger bubbles, and having easily overcome the somewhat greater counter-pressure of the mercury column s_1 they rise into the ball P.

All these manipulations are performed *entirely automatically* by the apparatus. At the same time that the toothed wheel has commenced working (*i.e.* when the volume of air pumped out by the pump has sufficiently diminished) the vessel P is entirely cut off from the hydrostatic air-pump by the cock t_1, thus ceasing to act. The mercury of the pump is entirely shut off on *both sides* from the exterior air, and only in contact with perfectly *dry* air. After stopping the pump, concentrated sulphuric acid may be sucked up into P, which dries up entirely. The mercury is shut off from M by a caoutchouc bag, I.

The following experiments were made at the Physical Institute of the University of Berlin:

400 c.cm. (cubic centimetres) were evacuated to 1/1000 m.m. in ten minutes; 4000 c.cm. = 4 litres, in an hour.

The highest rarefaction hitherto obtained has been about from 1/6000,00 – 1/800,000 m.m. = to about $\frac{1}{480000000} - \frac{1}{600000000}$ atmospheres.

The pump is supplied by Messrs. E. Leybolds Nachfolger, Cologne (Germany).

AUGUST RAPS.

CRYSTALLISED CARBON.

IN the course of some researches on the properties and modes of formation of the various forms of carbon, M. Henri Moissan has succeeded in reproducing the variety of diamond known as *carbonado*, or black diamond, and has even obtained some minute crystals of the colourless gem. An account of his results in the *Comptes Rendus* of February 6 is followed by an article on the reproduction of the diamond, by M. Friedel, and some congratulatory remarks by M. Berthelot.

As long ago as 1880 Mr. Hannay[1] indicated the formation of diamond-like crystals on heating under high pressure, in a tube of iron, a mixture of lithium, lampblack, essence of paraffin, and bone oil. It was then supposed that the nitrogenous compounds of the last substance played the most important part. In M. Moissan's new process carbon obtained from sugar is dissolved in a mass of iron, and allowed to crystallise out under high pressure. To produce this pressure the expansion of iron during condensation is utilised. The carbon is strongly compressed in an iron cylinder closed with a screw-stopper of the same metal. A quantity of soft iron, weighing about 150 or 200 gr., is melted in the electric furnace in a few minutes, and the cylinder is plunged into the molten mass. The crucible is at once taken out of the furnace and splashed over with water. When the external crust is at a red heat the whole is allowed to cool slowly in air.

The metallic mass thus obtained is attacked by boiling hydrochloric acid until all the iron is removed. There remain three forms of carbon: graphite in small quantity; a chestnut-coloured carbon in very small needles, such as has been found in the Cañon Diablo meteorite; and a small quantity of denser carbon which has to be further isolated. For this purpose the mixture is treated alternately with boiling sulphuric and hydrofluoric acids, and the residue decanted in sulphuric acid of density 1·8. It then contains only very little graphite, and various forms of carbon. After six or eight treatments with potassium chlorate and fuming nitric acid, the residue is boiled in hydrofluoric acid and decanted in boiling sulphuric acid to destroy the fluorides. It is then washed and dried, and bromoform is employed to separate out some very small fragments denser than that liquid, which scratch the ruby, and, when heated in oxygen at 1000°, disappear.

Some of these fragments are black, others transparent. The former have a rough surface, and a greyish black tint identical with that of certain carbonadoes; they scratch the ruby, and their density ranges from 3 to 3·5. Some pieces have a smooth surface, a darker colour, and curved edges. The transparent fragments, which appear broken up into small pieces, have a fatty lustre, are highly refractive, and exhibit a certain number of parallel striæ and triangular impressions.

During combustion in a current of oxygen at 1050°, some of the fragments left cinders of an ochreous colour, usually preserving the original form of the small crystal—just as in the combustion of impure diamonds.

As indicated already by Mr. Sidney Marsden,[1] silver heated to 1500° in presence of sugar carbon is found to contain on cooling some black crystals with curved edges. M. Moissan has found that high pressure is indispensable. He heated silver till it boiled briskly in contact with carbon, and found that a certain quantity of the latter was dissolved. By suddenly cooling in water, a portion of liquid silver, cooling inside a solid crust, was subjected to a very high pressure. No diamonds were formed, but rather a large crop of carbonadoes of densities ranging from 2·5 to 3·5, thus forming a series connecting graphite with diamond. Bromoform separated a carbonado, which scratched the ruby and burned in oxygen at 1000°. A quantitative determination of this reaction showed that 0·006 parts of this substance gave 0·023 of carbonic acid.

M. C. Friedel describes an experiment in which he obtained a black powder capable of scratching corundum by the action of sulphur on molten iron containing 4 per cent. of carbon. But the question of the production of diamond powder by this means is as yet an open one.

M. Moissan is continuing his researches on the solubility of carbon in iron, silver, and their alloys. It is to be hoped that he will soon be able to exhibit artificial true diamonds of a more imposing size.

1 Proc. Roy. Soc., vol. xxx. p. 188.

1 Proc. Roy. Soc. Ed. 1880, vol. ii. p. 20.

LINES OF STRUCTURE IN THE WINNEBAGO CO. METEORITES AND IN OTHER METEORITES.[2]

THE ground and polished surface of a Winnebago Co. meteorite showed to me some interesting markings. Subsequent examination revealed like markings in other meteorites. Perhaps these markings have been described. If so I have no recollection of the description, and therefore it seems worth while to call attention to them.

The polished surface of a small Winnebago stone, three or four square centimetres in area shows several hundreds of bright metallic points. The larger iron particles in this surface have great varieties of shapes—the smaller

2 Reprinted from the February number of the *American Journal of Science*.

ones are usually mere points. When seen with a lens, or even at a distance from the eye suited to distinct vision there does not appear to be any regular structure or arrangement of the bright points. But if the surface is so held as to be a little beyond the place of distinct vision, and at the same time, turned around in such a way as to reflect always a strong light to the eye, either skylight or lamplight, there appear lines of points across the polished surface of the stone, which suggest very strongly the Widmanstaetten figures on metallic meteorites. At times, as the stone is turned, no lines can be detected. Again one set of parallel lines or two sets crossing each other become visible. Some of the sets are very sharply manifested, and some are so faint as to leave one in doubt whether the lines are real or only fancied. There are on the surface in question six or eight of these sets of lines.

A second surface was ground nearly parallel to the first, at about one centimetre distant from it, and like lines appeared on this parallel surface. Some of the lines, but not all of them, corresponded in direction in the two surfaces. Four more surfaces approximately at right angles to the first surface, and corresponding to the faces of a right prism, were then ground, and upon these surfaces the like sets of lines appear with more or less distinctness.

A slab of a Pultusk stone 6 × 7 centimetres shows over its entire surface like markings. Something like a curvature of the lines appears in one instance, but in general the lines run straight from side to side of the slab. The slab is six millimeters in thickness, and most of the sets of lines have the same directions upon the two sides.

A Hessle stone, a small slice from the Wold Cottage stone, one from Sierra di Chaco, one from a Sienna stone, a fragment from the Rockwood stone, and a slice from the Rensselaer Co. stone, all show with more or less clearness the like markings. Of three microscope slides of the Fayette Co. meteorite one shows them clearly, a second shows traces of them, the third not at all.

A considerable number of the ground surfaces of meteoric stones in the Peabody Museum also show these markings. For example, a triangular surface of a Weston stone, 8 or 10 centimetres to each side, exhibits them very well.

These markings are such as we might expect if the forces which determine the crystallisation of the nickel-iron of the iron meteorites also dominated the structure of the rock-like formations of the stony meteorites and the distribution therein of the iron particles. The relation of quartz crystals to the structure of graphic granite is naturally suggested by these meteorite markings.

H. A. NEWTON.

THE LATE THOMAS DAVIES, F.G.S.

MR. THOMAS DAVIES, who died on December 21 last, was born on December 29, 1837, in the neighbourhood of London, and was the son of Mr. William Davies, F.G.S., of the Geological Department of the British Museum. His early education was of a very elementary character, and the period of his school-life was brief: finding town-life irksome, and yearning for freedom and adventure, he took to the sea at the age of fourteen, and during the next four years led a roving life, visiting China, India, and various parts of South America. He was then prevailed upon by his father to adopt a more settled mode of existence, and on the separation of the Department of Mineralogy from that of Geology was appointed in 1858 a third-class attendant at the British Museum under Prof. Maskelyne, to whom the care of the minerals had been assigned; in the following year he added to his responsibilities by marriage.

During the next nine years, save for a short interval when Dr. Viktor von Lang was an assistant in the Department, Mr. Davies was the sole helper of Mr. Maskelyne in the arrangement and examination of the mineral collections; during this time Mr. Maskelyne effected a thorough change in the classification and arrangement of the minerals, and in labelling with localities the large number of specimens that were without any descriptions except what could be traced out in old catalogues. In this work, and in the cleaning and arranging some tons of specimens, of which many were entirely valueless, the patient and intelligent aid of "young Davies" alone rendered it possible to carry out the preliminary operations. As the collection grew into orderly arrangement, the registration and labelling of specimens was entrusted to him by Mr. Maskelyne. It was thus that he gradually acquired an eye-knowledge of minerals which has rarely, if ever, been surpassed. His perception of the peculiarities of a specimen was remarkably quick, while his remembrance of individual specimens was almost marvellous. It was particularly in the habit, the locality, the associations and modes of occurrence of mineral species that he concentrated his interest; and to his knowledge in this direction his earlier training, under the eye of Mr. Maskelyne, in the labelling of the minerals, accumulated in the cases and drawers of the collection, very largely contributed.

In the early years of Mr. Davies's museum life Mr. Maskelyne was further engaged in the study of thin sections of meteorites, and initiated Mr. Davies into a knowledge of the microscopic characters of rock-forming minerals, a mode of investigation then almost unknown. In this direction his quickness of perception and excellence of memory had full scope for play, and Mr. Davies soon became extremely skilful in the microscopic determination of minerals in rock-sections, and in the recognition of peculiarities of rock-structure. Few practical petrologists approached him in this faculty.

Nor did he neglect to improve his general education. With this end in view he attended the evening classes at the Working Men's College in Great Ormond Street, and in the course of time acquired a knowledge of both French and German. He was also familiar with plants and fossils, a knowledge largely derived from his father.

His remarkable qualifications attracted the early attention of Mr. Maskelyne, and in 1862 were officially recognised in his promotion by the trustees from the grade of attendant to that of transcriber or junior assistant. In 1880 he was promoted to the grade of first-class assistant. By a remarkable coincidence his father, Mr. William Davies, who had long been renowned for his large practical knowledge of important branches of palæontology, and especially of fossil fishes, and had likewise begun museum life as an attendant, obtained the same promotion on the same day. In the same year Mr. Davies was awarded the balance of the proceeds of the Wollaston Fund by the Council of the Geological Society as a testimony of the value of his researches in mineralogy and lithology. Still later, in 1889, the name of *Daviesite* was given to a new mineral "in honour of Mr. Thomas Davies, who has now been associated during upwards of thirty years with the British Museum Mineral Collection, and whose mineralogical experience and Breithauptian eye have ever been willingly placed at the service, not only of his colleagues, but of every one who has been brought into relationship with him."

He became a Fellow of the Geological Society in 1870, and was an early member of the Mineralogical Society of France.

His published work was not voluminous; it relates almost exclusively to the microscopic characters of the pre-Cambrian rocks. He contributed, however, the bulk of the articles on mineralogy and petrology for "Cassell's Encyclopædic Dictionary," and for some years edited the *Mineralogical Magazine*.

Mr. Maskelyne, for whom he was right-hand man, and almost sole working helper during upwards of twenty years, looks back with fond regret on the uninterrupted happiness of their association. According to my own experience of the last fifteen years, he was an excellent colleague, always cheerful, good-tempered, and kind-hearted, ever ready to help in any direction, however much it might interfere with the particular work he had immediately in hand. At home he was an enthusiastic gardener; wet or fine, absolutely reckless of weather, he was at work from early sunrise, and could boast the possession of one of the best managed gardens in the neighbourhood. His love of fresh air and the bustling east wind never left him; even after recovery from the long illness which two years ago had taken him to the verge of the grave, he did not hesitate to show the greatest contempt for the protection of an umbrella, and notwithstanding the remonstrances of his friends, might still be occasionally seen enjoying the beating of the wind and rain on his unprotected face.

He was an Original Member of the Mineralogical Society, and Foreign Secretary for several years preceding his death.

Mr. Davies leaves a widow and nine children to mourn his loss. L. FLETCHER.

NOTES.

AT the last meeting of the Council of the Mineralogical Society, it was resolved to initiate a "Thomas Davies Memorial Fund" on behalf of the widow and children of the late Mr. Thomas Davies, F.G.S., of the British Museum. The following gentlemen have consented to act as an Executive Committee:—Prof. N. S. Maskelyne, F.R.S. (chairman), Dr. Hugo Müller, F.R.S. (treasurer), Mr. H. A. Miers, F.G.S. (secretary), Prof. T. G. Bonney, F.R.S., Mr. L. Fletcher, F.R.S., Dr. Henry Hicks, F.R.S., W. H. Hudleston, F.R.S., Prof. J. W. Judd, F.R.S., Mr. F. W. Rudler, F.G.S., Mr. F. Rutley, F.G.S., Rev. Prof. T. Wiltshire, F.G.S., Dr. Henry Woodward, F.R.S. Subscriptions for the fund should be sent to Dr. Hugo Müller, 13 Park Square East, Regent's Park, London, N.W.

AN extra meeting of the Chemical Society will be held on February 20, at 8 p.m., the anniversary of the death of Herman Kopp, when a lecture will be delivered by Prof. T. E. Thorpe, F.R.S. Lord Playfair will be in the chair.

AN International Botanical Congress is to be held during the Columbian Exposition at Chicago. Prof. C. E. Bessey will receive communications on the subject.

M. P. DUCHARTIE has been elected president, and M. L. Guignard first vice-president, of the Botanical Society of France for the year 1893.

THE annual public meeting of the University College Chemical and Physical Society will be held at University College, Gower Street, on Friday, February 24. The chair will be taken at eight o'clock by Prof. F. T. Roberts, and Prof. Watson-Smith will deliver an address on diseases incident to work-people in chemical and other industries.

MR. THOMAS BRYANT, president of the Royal College of Surgeons, delivered the Hunterian oration on Tuesday afternoon in the theatre of the college, in the presence of the Prince of Wales and the Duke of York and a large and distinguished company. Mr. Bryant began by thanking their Royal Highnesses for their presence on the special occasion of the centenary of the death of John Hunter, the great founder of scientific surgery. In the course of his oration Mr. Bryant said that the whole world of vegetable and animal life was Hunter's subject, but that his main objects were the improvement of surgery by the elucidation of pathology; the examination of the causes which determine any departure from the normal type, whether of form or function; and the study of the means which nature adopts for the healing of wounds and the repair of injuries. It was one of his special merits that he raised surgery out of the position of a a poor art, based on empirical knowledge and practised too much as a trade, to establish it firmly as a high and elevating science, at the same time raising its practitioners in the social scale, and doing as much for medicine as for surgery, for he considered them inseparable. He made the profession scientific by basing it upon the widest knowledge of the structure and functions of all living things, and educed therefrom laws and principles for the guidance of future generations in their study and treatment of disease in any of its forms. This alone should render him worthy of the thanks of civilised mankind.

MR. GEORGE MATHEWS WHIPPLE, whose death we briefly recorded last week, had done much solid and valuable work in various departments of physical science. Among the subjects in which he was especially interested were wind force and wind velocities, and throughout the greater part of his life, as the *Times* has said in a brief sketch of his career, he was constantly carrying on experiments with a view to determine wind force and to find out what were the best instruments for securing accurate results. He improved the Kew pattern magnetic instruments; he designed, among other instruments, the apparatus for testing the dark shades of sextants; and at various periods he was associated with Captain Heaviside, Major Herschel, and General Walker, in carrying on pendulum experiments for the determination of the force of gravity. The magnetic part of the report of the committee appointed by the Royal Society to investigate the Krakatoa eruption and the subsequent phenomena was prepared by Mr. Whipple, and valuable papers were from time to time submitted by him to the Royal Society and the Royal Meteorological Society. He was fifty years of age at the time of his death. He entered the Kew Observatory in 1858, became magnetic assistant in 1862, and was appointed superintendent in 1876. This office is one of great and growing importance, and we trust that a capable successor may be found. The Kew Observatory is the central standardising station of the Meteorological Office, and numerous magnetical observatories in other countries are similarly connected with it. New instruments are tested there, and experiments are made, and it has now grown into an institution where the verification of scientific instruments of many kinds, including thermometers, sextants, telescopes, watches, and recently photographic lenses, is carried on on a large scale, as described in the annual report of the Kew committee to the Royal Society.

THE Rev. F. O. Morris died at Nunburnholme, in Yorkshire, on Friday last, at the age of eighty-two. He was well-known as a popular writer on science, and did much to create and foster interest in some branches of natural history, especially in ornithology. Among his many books were "A History of British Birds," issued in six volumes from 1851 to 1857, and his "Natural History of the Nests and Eggs of British Birds," published in three volumes in 1853. In 1854 he was presented to the rectory of Nunburnholme, which he continued to hold until his death.

A DESTRUCTIVE earthquake has taken place in the island of Samothrace. All the buildings are said to have been destroyed. Renewed shocks, accompanied by loud subterranean rumblings, have also occurred at Zante.

ON Sunday a shock of earthquake was experienced in New Zealand. It caused little damage, but was felt in both the North and South Islands, being most severe at Wellington and at Nelson.

THE weather of the past week has been very stormy and damp in most parts of these islands; scarcely a day has passed without gales being reported. On Friday, the 10th, the wind force was especially strong, on the north-east coast of Scotland and in the English Channel, and on Tuesday another deep depression had reached our northern coasts from off the Atlantic, accompanied by strong gales. The United Kingdom was situated between two areas of high barometer readings, one of which lay over Scandinavia and the other over France and Spain. With this distribution of pressure, the conditions were favourable to the passage of cyclonic disturbances within our area, and although the storms were not of exceptional violence in the southern districts, they were so relatively, as the winds have been peculiarly quiet during the last twelve months. Temperature has been a little above the mean for the season, the daily maxima often exceeding 50°, but on Sunday the highest day readings were below 40° over the north-east of England, while a sharp frost occurred in the north of Scotland, the minimum temperature registering 20°. On the continent the temperature has been much lower than in this country; at Haparanda, at the north of the Gulf of Bothnia, which lies in the area of the high barometric pressure over Scandinavia, a temperature of minus 37° was recorded on Friday and Saturday. Rainfall has been of daily occurrence at most stations, although the amounts measured have generally been light, while hail and sleet have occurred in many places. With Tuesday's storm, however, the rainfall exceeded an inch on the west coasts of Ireland and Scotland. By the *Weekly Weather Report* of the 11th instant it appears that the rainfall for that week was greatly in excess of the mean in the north and west of Scotland, and to a less extent in the east of Scotland, the north of Ireland, and the western parts of England. Bright sunshine exceeded the mean in all districts, the greatest amounts, 32 to 38 per cent., being recorded in most parts of England.

THE recent numbers of *Ciel et Terre* (Nos 21–23) contain interesting articles on ozone. The observation of this element by meteorologists has been almost given up in most countries, owing chiefly to the difficulty of obtaining comparable results by the methods at present in use, although its importance for invalids and others as a purifier of the atmosphere is generally acknowledged. And at a recent meeting of the Royal Meteorological Society, regret was expressed at the discontinuance of these observations. D. A. Van Bastelaer, in conjunction with the Royal Observatory of Brussels, maintained a system of ozone observations at 150 of the stations belonging to the Society of Public Medicine in Belgium during the years 1886–91, which is probably the most complete investigation into the subject which has been made. The values found for the various stations are given in a tabular form, and M. Van Bastelaer found that there are continual and sudden variations in the records from hour to hour, between morning and evening, and from one day to another, but that the mean values for any locality remain nearly constant. Isolated values are of no use; a long series of observations is necessary for any results of importance to be arrived at. The air at stations near the sea coast contained, as is usually supposed, the greatest amount of ozone.

THE Indiana Academy of Science lately held at Indianopolis its eighth annual meeting, the president being Prof. J. L. Campbell, of Wabash College, Crawfordsville, Ind. There was a large attendance, and no fewer than ninety-two papers had been prepared, most of which were read. The first volume of the Academy's Proceedings was distributed at the meeting.

THE *Kew Bulletin* continues, in the January number, its series of articles on the food grains of India, one of the subjects being Kangra Buckwheat (*Fagopyrum tataricum*, Gærtn., var. *himalaica*, Batalin). The typical plant is cultivated throughout the higher Himalayas, but more especially on the western extremity, and at altitudes from 8000 to 14,000 feet. The yield in India cannot yet be estimated, but the *Bulletin* says there can be little doubt that the seeds are singularly rich in nutrient constituents. This is confirmed by the conclusions of Prof. Church with regard to a sample he has examined.

THE January number of the *Kew Bulletin* contains also the fourth decade of new orchids, the fourth of "Decades Kewenses," papers on fruit growing at the Cape and the clove industry of Zanzibar, and miscellaneous notes.

PROF. R. SHIMEK is now investigating the flora and the geology of Nicaragua, along the route of the canal, under commission from the State University of Iowa. Dr. Terracciano, of Rome, is about to renew his investigation of the flora of Erythrea, the Italian colony on the Red Sea. Dr. K. N. Denkenbach is commissioned by the Natural History Society of St. Petersburg to investigate the flora of the Black Sea.

MR. R. THAXTER proposes in the *Botanical Gazette* the establishment of a new order of Schizomycetes, the Myxobacteriaceæ, somewhat intermediate in its characters between the typical Schizomycetes and the Myxomycetes. It comprises the genus Chondromyces, placed by Berkeley, in his "Introduction to Cryptogamic Botany," under the Stilbacei, and two new genera, Myxobacter and Myxococcus. The order consists of mobile rod-like organisms, multiplying by fission, secreting a gelatinous base, and forming pseudo-plasmode-like aggregations before passing into a more or less highly-developed cyst-producing resting state, in which the rods may become encysted in groups without modification, or may be converted into spore-masses.

AT the meeting of the Royal Botanic Society on Saturday, one of the branches of the flowering stalk of *Fourcroya selloa* was shown from the Society's conservatory. This is a Mexican plant allied to the aloes, and like them it flowers only once during its life. The plant, which has been in the conservatory for upwards of twenty years, late last autumn threw up a flower spike which in a very short time grew to a height of 30 feet, and, passing through the glass roof, rose for some feet into the open air. It could not, of course, resist the frosts and fogs of winter. The flower-buds dropped unopened, when immediately from each node a number of young plants appeared. This mode of reproduction is found in only a few varieties of plants, and is especially valuable in relation to the cultivation of Fourcroyas as a source of commercial vegetable fibre.

THE Newcastle Literary and Philosophical Society will have no very pleasant associations with the memory of its hundredth anniversary, which was celebrated on Tuesday of last week. During the following night the society's premises caught fire and were greatly damaged. Much injury was done to the library, where many most valuable books were destroyed.

THE fifth and sixth parts of the fifth volume of the *Internationales Archiv für Ethnographie* have been issued together in a single number. It includes the second part of Dr. W. Svoboda's interesting study (in German) of the inhabitants of the Nicobar Islands; a paper (in French) by Désiré Pector on the volume by Dr. Hyades and Dr. Deniker (noticed some time ago in NATURE) on the ethnography of a part of Tierra del Fuego; a suggestive essay (in German) by Dr. T. Achelis, on the psychological importance of ethnology; and the second part of Dr. Schmeltz's careful contributions (in German) to the ethnography of Borneo. The first and last of these papers are admirably illustrated. A valuable paper on the Ainos, by David MacRitchie, of Edinburgh, has been published as a supplement to the fourth volume of the *Archiv*. This paper is accompanied by, and contains full descriptions of, a series of coloured reproductions of most interesting pictures of Aino life by Japanese artists, who have naturally a keener perception of the characteristics of their savage neighbours than can be attained by Western visitors. Mr. MacRitchie seeks to show that the Ainos display "unmistakable traces of a near descent, by at least one line of their ancestry, from the most crude form of humanity."

MESSRS. SAMSON AND WALLIN, Stockholm, are about to issue what promises to be an important and interesting work, by F. R. Martin, on the Siberian Antiquities of the Bronze Age, preserved in the museum of Minousinsk. Nearly 900 objects in copper and bronze will be represented in the plates, which, according to the prospectus, are being prepared with the greatest care. The antiquities of which these objects are selected specimens were collected in 1874 by M. Nicolaï Martianow from mounds in the steppes of the Upper Yenisei. They are the finest provincial collection in the Russian Empire, and M. Martin found much to interest him in classifying and photographing them. The present volume will be the first of a series of works on the ethnography and archæology of Western Siberia by the same writer.

THE third volume of "A Journal of American Ethnology and Archæology," edited by J. Walter Fewkes, has been issued. It contains an interesting "outline of the documentary history of the Zuñi tribe," by A. F. Bandelier, and "somatological observations on Indians of the south-west," by Dr. H. F. C. Ten Kate. It is worth while to note that in Dr. Ten Kate's opinion the study of physical anthropology among the North American Indians does not tend to demonstrate that their types are exclusively American. It rather shows, he thinks, that they present only the characteristics of "the Mongolian or so-called yellow races." "I do not mean," he says, "that the American aborigines are Mongolians in the strict sense of the word, or that America has been populated from Asia. Where the Indians came from I do not know, but my position is as follows:—The American race is, somatologically speaking, not a type, but has characteristics which can only be called Mongoloid."

PROBABLY no living sportsman has shot more big game in South Africa than Mr. F. C. Selous, who for years was more at home in a waggon or a tent somewhere in the far countries of Africanderland than in the towns and settlements of the Cape Colony or the Transvaal. He has nearly completed an account of eleven years' sport and travel, which will be shortly published by Messrs. Rowland, Ward and Co., of Piccadilly. It will be fully illustrated, and will include a variety of general information on subjects of interest in connection with the latest developments of South African exploration.

MR. ELLIOT STOCK has published the third volume of "The Field Club," a magazine of general natural history for scientific and unscientific readers, edited by the Rev. Theodore Wood. The volume contains many articles which are well fitted to awaken interest in various aspects of natural science.

WE referred lately to Dr. D. G. Brinton's opinion as to the relation between nervous diseases and civilisation. As his view has been called in question by Dr. Rockwell, he returns to the subject in *Science*, supporting his own conclusions by a reference to a paper contributed by Dr. I. C. Rosse, professor of nervous diseases at the Georgia Medical College, to the *Journal of Nervous and Mental Disease* for July, 1891. In this paper Dr Rosse cites many authorities to prove that there is as much nervous disease at low as at higher stages of civilisation, and perhaps more. In the district of Columbia, for example, the decedents among the coloured people from nervous diseases often exceed those of the white population by thirty-three per cent. Dr. Rosse is inclined to believe that a sudden change in the social habits and condition of any race, at any stage of advancement, will result in a prompt development of neurotic disease. A high civilisation, which is stable, excites such a condition less than instability in lower grades.

AT the meeting of the Field Naturalists' Club of Victoria in November a paper presenting a list of species of Victorian butterflies was communicated. It had been prepared by Messrs. F. Spry and Ernest Anderson, and embodied the results of work carried on during many years. The *Victorian Naturalist* says the paper was "received with great satisfaction, and will prove of extreme value to the Victorian lepidopterist."

MR. H. L. CLARK records in *Science* what he calls "a bit of satisfactory evidence" as to the rate of speed in the flight of certain birds. He thinks that this is often greatly exaggerated. He was travelling lately on the Baltimore and Ohio Railway, up the valley of the Potomac, when he saw a great many wild ducks, which are admitted to be among the strongest flyers in America. It so happened that, on rounding a sharp curve, the train flushed a pair of buffle-heads, which started up stream at full speed. On watching them he found that, instead of their leaving the train behind, the train was actually beating them, and he is confident that their rate of speed was not equal to that of the train. "We kept alongside of them," he says, "for nearly a minute before they turned back down-stream. Careful calculation showed that the train was running at about thirty-seven miles per hour, so that the rate of speed for those wild ducks would be about thirty-six. I hope that others may have some evidence on this question of speed in flight which will throw more light on the subject."

AN interesting illustration of the tendency of inorganic matter to simulate the forms seen in organic is afforded by some specimens of hæmatite from a mine in Lake Superior district. It is described in the *American Geologist* as a fibrous red hæmatite, compact and tough-looking, and the radiating filaments or fibres towards their summits are seen to spread out like some frondescent vegetable growths. It would seem that in process of increase these fibres, starting from different but slightly distant points, and having a tendency to expand, soon began to interfere with one another. The line of contact, which became a plane as growth continued, is marked by a more or less distinct plane of separation. This frondescent hæmatite, in addition, is pierced by a number of peculiar channels which seem to date from the time of development of the crystals. It is noticed that these run, in general, perpendicular to the fibrous structure, and lie in or across the planes of contact of two oppositely spreading frondescent growths. These appear to mark in the first instance the vacancies left by the first contacts of overarching growths from opposite directions. These branches then interfered with the free circulation of air, and interrupted and permanently stopped the development of these fibres beneath the overspreading canopy.

IT was shown by Ferraris some time ago (and the fact was of great practical importance) that by means of two simple alternating currents acting in fixed spirals, a rotating magnetic field could be produced, which by inductive action set in rotation a copper cylinder or other conducting body brought into the field. Also an iron cylinder, cut through so that the Foucault induction currents could not be formed, was rotated by virtue of so-called magnetic hysteresis. Further studies in this direction have been made by Signor Arno, using electric instead of magnetic forces, and a dielectric body instead of a magnetic.

He thus succeeded in rotating a hollow cylinder of mica, or other insulating substance, hung by a silk fibre, in the space enclosed by four vertical curved copper plates, to which the requisite differences of potential were communicated. An account of these interesting experiments (described to the Accademia dei Lincei) will be found in the *Naturwissenschaftliche Rundschau*, No. 3, 1893.

PROF. R. C. SCHIEDT has been making some interesting observations on oysters, and at a recent meeting of the Philadelphia Academy of Natural Sciences Prof. Ryder reported on his behalf that oysters which had the right valve removed and were exposed to the light in this condition, in a living state for a fortnight or so, developed pigment over the whole of the epidermis of the exposed right mantle and on the upper exposed sides of the gills, so that the whole animal from this cause assumed a dark-brown colour. Animals so exposed not only attempted to reproduce the lost valve and hinge, but also partly succeeded in so doing, even re-establishing the insertion of the diminutive pedal muscle upon the inner face of the imperfectly reproduced right valve, which was deformed owing to the lack of support of the right mantle, because of the removal of the original right valve. As a consequence the right mantle was rolled up at the edge, and this deformation of the mantle was reflected in the attempted regeneration of the lost right valve. The pigment developed during exposure to light in the mantle and gills in oysters with the right valve removed, which were kept alive in the aquaria at Sea Isle City by Prof. Schiedt, was wholly confined to the epidermis as it normally is at the mantle border in the unmutilated animal in nature. The inference to be drawn from these facts is that the development of pigment in the mantle and gills was wholly and directly due to the abnormal and general stimulus of light over the exposed surface of the mantle and gills, due to removal of the right valve, and that the mantle border, the only pigmented portion of the animal, is pigmented because it is the only portion of the animal which is normally and constantly subjected to the stimulus of light.

MR. D. CLEVELAND, of San Diego, California, contributes to *Science* an article in which he states some curious facts regarding the trap-door spider (*Mygale henzii*, Girard), which is widely diffused in California. Behind San Diego there are many hillocks about a foot in height and three or four feet in diameter. These hillocks are selected by the spiders, Mr. Cleveland suggests, because they afford excellent drainage and cannot be washed away by the winter rains. A suitable spot, which always consists of clay, adobe or stiff soil, having been chosen, the spider excavates a shaft varying from five to twelve inches in depth, and from one-half to one and a half inches in diameter. This is done by means of the sharp horns at the end of the spider's mandibles, which are its pick and shovel and mining tools. The earth is held between the mandibles and carried to the surface. When the shaft is of the required size, the spider smooths and glazes the wall with a fluid which is secreted by itself. Then the whole shaft is covered with a silken paper lining, spun from the animal's spinnarets. The door at the top of the shaft is made of several alternate layers of silk and earth, and is supplied with an elastic and ingenious hinge, and fits closely in a groove around the rim of the tube. This door simulates the surface on which it lies, and is distinguishable from it only by a careful scrutiny. The spider even glues earth and bits of small plants on the upper side of the trap-door, thus making it closely resemble the surrounding surface. The spider generally stations itself at the bottom of the tube. When, by tapping on the door, or by other means, a gentle vibration is caused, the spider runs to the top of its nest, raises the lid, and looks out and reconnoitres. If a small creature is seen, it is seized and devoured. If the invader is more formidable, the door is quickly closed, seized, and held down by the spider, so that much force is required to open it. Then the spider drops to the bottom of the shaft. When the door of the nest is removed, the spider can renew it five times—never more than that. From forty to fifty cream-coloured spiderlings are hatched from the yellow eggs at the bottom of the nest. When these have attained only a fraction of their full size—before they are half grown—the mother drives them out into the world to shift for themselves. After a brief period of uncertainty they begin active life by making nests, each for itself, generally close to "the old homestead," sometimes within a few inches of it. These nests are always shallow and slender, and are soon outgrown. When the spider attains its full size it constructs a larger nest.

AN interesting paper concerning the supposed volatility of the element manganese is contributed by Prof. Lorenz and Dr. Heusler, of Göttingen, to the current number of the *Zeitschrift für Anorganische Chemie*. Although the melting point of the metal is known with tolerable certainty to be about 1800°–1900°, much higher than that of iron, no information has yet been acquired concerning its boiling point. Profs. Lockyer and Chandler Roberts, however, so long ago as 1875 pointed out that the metal was volatile at the temperature of the oxy-hydrogen blowpipe; and M. Jordan, in a communication to the *Comptes Rendus* in the year 1878, reported that in the manufacture of highly manganiferous spiegeleisen near Marseilles, a deposit very rich in manganese was usually found in the cooler portions of the furnace. Moreover, M. Jordan stated that during the casting of ferro-manganese red flames are produced, from which a heavy fume is deposited containing a large percentage of manganese. M. Jordan subsequently heated ferro-manganese to a white heat in a crucible in his laboratory, and ascertained that a diminution in the percentage of manganese actually occurred. These observations were considered somewhat surprising, inasmuch as the melting point of manganese is so high, in the neighbourhood of white heat, and it would appear that this volatility must be exhibited even at the melting point itself.

PROF. LORENZ and his colleague have therefore conducted a series of experiments with the view of ascertaining whether manganese is really volatile *per se*, or whether the volatility is due to the intermediate action of carbon monoxide (derived from the carbon usually present) in forming a volatile but dissociable compound of a nature similar to nickel- and iron-carbonyl. It was first definitely proved that carbon monoxide does not combine with manganese below the temperature of 350°, a fact which M. Guntz has recently independently pointed out. Experiments were then made at higher temperatures, using a new form of combustion furnace, designed by Prof. Lorenz and fully described in the *Zeitschrift*, in which each individual burner is supplied with a blast capable of being regulated, the whole apparatus being equivalent to a row of blowpipes which will rapidly raise a thick porcelain tube up to a white heat. In the first series of these high temperature experiments coarsely powdered manganese containing seven per cent. of carbon was heated to whiteness in a glazed porcelain tube in a current of carbon dioxide, in order that nascent carbon monoxide might be produced in contact with manganese by the reduction of the carbon dioxide by the carbon present. After half-an-hour's heating the tube was allowed to cool in the stream of carbon dioxide and then broken, when it was found that a large quantity of the manganese had volatilised and condensed again further along the tube, in the form of a thick black deposit somewhat resembling zinc dust. Upon repeating the experiment with a current of carbon monoxide, a similar result was obtained. Hence manganese is certainly volatile in carbon monoxide. But it was afterwards found that equally good deposits of manganese dust were obtained when a current of either hydrogen or nitrogen, neither of which combine with manganese, were employed. It is therefore evident that manganese does not resemble iron and nickel in forming a volatile compound with carbon monoxide, but that the volatility is a property of the element itself, and is singularly manifested even at the temperature of the melting point.

SOME of the more interesting captures recently made by the dredging staff of the Marine Biological Association at Plymouth are the Actinian *Chitonactis coronata;* the Nudibranchs *Berghia cœrulescens* (new to Britain), *Amphorina cœrulea*, and *Lamellidoris oblonga* in considerable numbers; and the handsomely marked rare spider-crab, *Stenorhynchus egyptius.* The alga *Halosphæra viridis* has been present in all townettings since October; and *Noctiluca*, though in small numbers, is now generally present. The breeding season of a large number of Invertebrata has already commenced, and the sea swarms with Copepod and Cirrhipede Nauplii, and with Polychæte larvæ. Species of the following genera are breeding:—The Hydroids *Halecium, Plumularia, Sertularella, Hydrallmania;* the Actinians *Chitonactis* and *Actinia;* the Nemertine *Lineus obscurus* (larva of Desor); *Phyllodoce maculata* and other Annelids; the Molluscs *Capulus hungaricus, Lamellaria, Buccinum, Purpura,* many Nudibranchs; and the Decapod Crustacea *Crangon, Pandalus,* and *Palæmon; Carcinus, Cancer,* and *Eurynome.*

THE additions to the Zoological Society's Gardens during the past week include a Fallow Deer (*Dama vulgaris* ♂) European, presented by Mr. B. L. Rose; a Great Eagle Owl (*Bubo maximus*) European, presented by Mr. Adolphus Drucker; two Gold Pheasants (*Thaumalea picta* ♀ ♀) from China, presented by Miss Forster; nine Snow Buntings (*Plectrophanes nivalis*) British, presented by Mr. T. E. Gunn; an Egyptian Cobra (*Naia haje*), two Hoary Snakes (*Coronella cana*), from Victoria West, Cape Colony, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; three European Pond Tortoises (*Emys europæa*) European, deposited; a King Snake (*Coluber getulus*) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE OF APRIL 15–16, 1893.—The following particulars of the phenomena of the total solar eclipse of April 15–16, 1893, have been supplied to the Eclipse Committee by Mr. A. M. W. Downing, Superintendent of the *Nautical Almanac* office, for the use of the English observers at the eclipse stations to be occupied in Brazil and Africa:—

Brazil. Longitude 38° 50′ W. Latitude 3° 20′ S.

		d. h. m. s.	Contact from N. point.	Contact from vertical.	Sun's altitude.
Eclipse begins	April	15 22 18 14	136° W.	19° W.	62°
Totality begins		15 23 40 51	Duration 4m. 43·1s.		
Totality ends		15 23 45 34			
Eclipse ends		16 1 11 40	45° E.	84° W.	68°

Local mean times.

Senegambia. Longitude 16° 30′ W. Latitude 14° 15′ N.

		d. h. m. s.	Contact from N. point.	Contact from vertical.	Sun's altitude.
Eclipse begins	April	16 1 5 3	130° W.	156° E.	73°
Totality begins		16 2 27 59	Duration 4m. 12·3s.		
Totality ends		16 2 32 12			
Eclipse ends		16 3 48 1	57° E.	24° W.	35°

Local mean times.

REMARKABLE COMETS.—Bearing this title, Mr. Lynn has written a small book, in which he gives a short survey of the most interesting facts that have occurred in the history of cometary astronomy. As he remarks in the preface, the scope of the work is almost purely historical; but we are sure there are many who will peruse these few pages with great pleasure, for the author has brought together these facts and presented them to the reader in a concise and plain style. We may mention that figures relating to elements of orbits, &c., are at a minimum, Mr. Lynn simply restricting himself to bare accounts. The author concludes by giving a list of the dates at which some of the comets may reappear, from which we make the following extract:—

Date.		Period in years.	
1893	Summer	6½	Finlay's Comet
1894	Winter	3⅓	Encke's ,,
1896	Spring	7½	Faye's ,,
,,	,,	7	Brook's ,,
1897	,,	6½	D'Arrest's ,,
,,	,,	5½	Swift's ,,
1898	Summer	5½	Winnecke's ,,
,,	Autumn	7	Wolf's ,,
1899	Spring	33½	Comet of 1866
,,	Summer	13¾	Tuttle's Comet
,,	,,	7	Holmes's ,,

The comet of 1866, as many of our readers well know, is identical with the meteoric stream through which we pass in November, so we hope that we shall be visited by a fine display.

COMET HOLMES (1892, III.).—Comet Holmes seems to have become somewhat dimmed during the past week, but we nevertheless give the ephemeris for the benefit of those who wish to follow it a little longer.

Ephemeris for 12h. M.T., Paris.

1893.	R.A. app. h. m. s.	Decl. app. h. m. s.
Feb. 16	2 7 37·9	+34 14 30
17	9 15·3	16 42
18	10 53·2	18 58
19	12 31·5	21 16
20	14 10·3	23 37
21	15 49·5	26 1
22	17 29·1	28 26
23	2 19 9·2	34 30 54

COMET BROOKS (NOVEMBER 19, 1892).—This comet lies in the southernmost part of the constellation of Andromeda, just south of ε Andromedæ, and the following is the current ephemeris:—

Ephemeris for 12h. M.T., Berlin.

1893.	R.A. app. h. m. s.	Decl. app. ° ′	Log r.	Log Δ	Br.
Feb. 16	0 22 44	+26 46·9			
17	24 8	26 23·2	0·1343	0·2445	0·97
18	25 30	26 0·3			
19	26 50	25 38·3			
20	28 8	25 17·1			
21	29 23	24 56·7	0·1438	0·2711	0·83
22	30 37	24 37·1			
23	0 31 49	24 18·2			

RELATIVE POSITIONS OF STARS IN CLUSTER χ PERSEI.—Volume xxx. part iv. of the Transactions of the Royal Irish Society contains the results of the investigations of Sir Robert Ball and Mr. Arthur Rambaut, with respect to the relative positions of 223 stars in the cluster χ Persei as determined photographically. The instrument used throughout was a 15-inch silver on glass reflecting telescope, mounted according to Cook's standard equatorial pattern. For the adjustment of the plate (the size used here being 3¼ × 3¼) and mirror Dr. Johnstone Stoney's collimator was employed, this method ensuring the exact perpendicularity of the photographic plate to the axis of the collimator. The negatives were measured with an instrument made by the same firm, and after the same pattern as that used by Prof. Pritchard, at Oxford, this instrument being supplied with the means of measuring either rectangular or polar coordinates, the former of which has been adopted here throughout. In this memoir the authors treat in detail, by means of figures and formulæ, the equations for orientating the plate for measurement, for computing the differences in Right Ascension and Declination from the centre of the plate, for correcting the relative apparent positions of the stars for effects of separation, observation, nutation, and procession, &c. The measures here given have been obtained from one photograph taken with an exposure of ten minutes, the images under the microscope being susceptible "of very accurate measurement." That only one negative has been employed is due, as the authors say, to pressure of other work and to necessary alterations in the instrument, but they hope to repeat the investigation next autumn. In the table showing the positions, the authors compare their results with those of Vogel and Pihl, and they find that a small difference, depending on the adopted position of the fundamental star, is apparent between the former's declinations, while Pihl's right ascensions differ slightly, though systematically, this discrepancy being due very probably to the different methods of determining the parallels. The memoir concludes with a map showing the relative positions of the stars plotted direct from the x and y coordinates.

L'ASTRONOMIE.—The February number of this journal contains many articles of interest. Prof. Stanislas Meunier gives an account of a meteorite that fell in Algeria; this meteorite has proved to be of iron, containing as much as 91·32 per cent., and a polished surface, when treated with an acid, showed the well-known Widmannstätten figures. M. Flammarion, in addition to an account of "Les Pierres Tombées du Ciel," with reference to "Les Anciens Volcans de la Lune," lately advocated by Prof. Coakley in *Astronomy and Astrophysics*, gives the fourth out of six chapters dealing with the question, "Comment Arrivera la fin du Monde." M. J. Fényi, director of the Observatory of Kalocsa, gives an account of the enormous solar eruption (383,000 kilometres high) that occurred on October 3 last, while a short note on some curious appearances undergone by comet Swift includes six drawings by M. Lorenzo Kropp, taken between March 18 and April 25, and the three photographs taken at the Lick Observatory by Mr. Barnard, all of which indicate the results of tremendous actions, whether they be due to the influences of different forces, "attraction, repulsion, chaleur, électricité, or changements d'état, qui ajissement sur ses astres gazeux dans leur voisinage du soleil." M. Weinck of Prague describes the results of his examination of the Lick negatives with reference to the lunar crater Flammarion, and gives a drawing (which, by the way, can be well seen by half closing the eyes) of its surroundings, together with the three new craters. This number also includes a general summary of the meteorology of the preceding year, the results being given in diagrammatic form, bringing out clearly the diurnal and monthly changes.

JUPITER'S FIFTH SATELLITE.—Mr. Barnard, who has been continuing his observations with respect to the fifth satellite of Jupiter, communicates the results he has obtained to the *Astronomical Journal* (Nos. 285-86). The values of the elongation distances deduced from the measures at elongations are, for eastern elongation, $48''\cdot089$ ($\pm 0\cdot061$), and for western elongation, $47''\cdot621$ (($\pm 0\cdot176$), the probable errors of a single determination being $\pm 0''\cdot23$ and $\pm 0''\cdot47$ respectively. These values are equivalent to the following distances:—

E. elongation	112,500 ± 143 miles
W. ,,	111,412 ± 412 ,,

The values for the period he gives as

		h. m. s.
September 10–October 21	...	P = 11 57 23·72
September 10–October 28	...	P = 11 57 23·30
September 10–November 20		P = 11 57 22·73

the mean, when proportional weights are applied, being—

11h. 57m. 23·06s.

Among some other figures which Mr. Barnard gives are:—

Hourly motion	30°·111
Velocity in orbit	16·4 miles per second
Equatorial Hor. Par.	21° 51′

Distance from surface of Jupiter 67,000 miles (about).

While working at this satellite he has also been led to measure the equatorial and polar diameters of Jupiter himself, and the following numbers show the values he has deduced, the observations being made through smoked glass:—

Equatorial diameter	89,790 ± 65 miles
Polar ,, ...	84,300 ± 80 miles

GEOGRAPHICAL NOTES.

THE *Times* Berlin correspondent furnishes some interesting notes of Dr. Baumann's recent journeys in the region of the Nile sources, which confirm Mr. Stanley's identification of the Mountains of the Moon. In Urundi the kings were supposed to be lineal descendants of the moon, and the white traveller was hailed as being the returned ghost of a lately-deceased chief. On September 11 the expedition crossed the Akenyaru, which is not, as supposed, a lake, but a river, though the name "Nyanza" is often applied to it. Dr. Baumann also discovered that the so-called Lake Mworengo is in reality a river which flows into the Akenyaru, and came to the conclusion that there was no extensive sheet of water in Ruanda or North Urundi. On September 19 Dr. Baumann arrived at the source of the Kagera (Alexandra Nile), which rises at the foot of the precipitous and wooded hills which form the watershed between the basins of Rufizi and the Kagera. This mountain chain is known to the natives by the name of the "Mountains of the Moon," and is held in peculiar reverence by them. Here Dr. Baumann maintains the real source of the Nile to be, for if "it be acknowledged that the Kagera is the chief feeder of the Victoria Nyanza, it follows that the headwaters of the Nile can be none other than those of the Kagera itself in the Mountains of the Moon in Urundi, within the boundaries of German East Africa."

THE often-discussed scheme of an expedition to the North Pole by way of Franz Josef Land has been revived by Mr. F. G. Jackson, who proposes to lead an expedition next summer, if the means for equipping a ship are forthcoming. Mr. Jackson's plan is to travel with a small party, and establish a chain of depots northward from the most northerly accessible landing-place in Franz Josef Land. He would remain during winter in the most advanced post, and push on each summer with dog-sledges, until the pole is reached. The plan rests on the hypothesis of Franz Josef Land extending to the pole, just as Dr. Nansen's rests on the hypothesis of a transpolar current, but the evidence of the great extension of the land is not very satisfactory. Mr. Jackson's previous Arctic experience is not stated, nor is there any indication given as to whether he intends to travel at his own expense or to appeal for pecuniary help.

THE British South African Company have reserved the Zimbabwe Ruins and the area within a radius of one mile from the top of Zimbabwe Hill for archæological and scientific purposes, and no settlements, farms, or mines will be permitted within that radius.

A BEAUTIFULLY illustrated report on the regulation of Swiss torrents, by the late M. de Salis, has recently been published by the Swiss Government. The natural erosion and surface change which go on at the present day so rapidly among the steep slopes of a mountainous country as to be frequently cataclysmic in their intensity, have to be avoided or endured in inhabited regions. A frequent source of floods is the damming up of a large river by the mud and stones brought down by a freshet in a small tributary. The method of combating this effect is to build a succession of weirs, and cut a parallel canal so that the sediment is caught and the overflow regulated before the escaping water reaches the main valley.

MR. MACKINDER'S fourth Royal Geographical Society's educational lecture, delivered last week, dealt with Central Asian trade- and travel-routes, under the title of "The Gates of India and China."

TWENTY YEARS IN ZAMBESIA.

MR. F. C. SELOUS, the famous hunter and explorer of South Central Africa, gave a summary of his travels to the Royal Geographical Society on Monday evening. His address was illustrated by an exhibition of unusual interest in the tea-room, where a large collection of stuffed specimens of the characteristic African mammalian fauna was arranged. Photographs and various objects illustrative of the rapid development of Mashonaland since the Chartered Company took possession were also shown.

Mr. Selous commenced his African wanderings in 1871, and except for occasional visits to England he has travelled and traded in that continent ever since. In 1872 he and some companions penetrated into Matabeleland to hunt elephants, and had an amusing interview with the chief, Lo-Bengula. Although at that time not an explorer in the scientific sense, the accurate memory of his early wanderings over the country enabled Mr.

Selous to successfully guide the Pioneer Force of the Chartered Company in 1890, when they took possession of Mashonaland.

With regard to the health of Zambesia he says:—"Owing to severe exposure to wet and cold during several days and nights, in the early part of 1872, I got an attack of fever and ague in Griqualand so that I was handicapped before starting for the interior. This fever and ague was exactly what I have seen people get on the high plateau of Mashonaland, during the last few years, from similar exposure to rain and cold. It took me some time to shake off, and was still in my system when I reached Matabeleland, but the attacks only came on when I halted anywhere for a few days. During November and December, 1872, hunting down in the low hot country towards the Zambesi, I was again very much exposed to wet, and on several occasions lay out all night long, without any shelter, drenched through with such heavy rain that it put out the largest fire and converted hard ground into a swamp. I naturally again got soaked with fever poison, but as long as I remained hunting the disease did not show itself. Directly I got back to Bulawayo it broke out, and during a month or so I had several sharp attacks. By that time, however, my sound constitution had choked all the fever germs, and from that day until in 1878, when very severe exposure in Central Africa once more filled me up with malarial poison, I do not remember ever to have had one single hour's illness, or to have taken one drop of medicine. The life I led was, however, if a very hard, at any rate, in many respects, a very healthy one; for the most part I ate nothing but meat and Mashona rice, and drank nothing but tea, usually without milk and sugar—not because I like it so, but because those adjuncts were unobtainable."

North of the Zambesi Mr. Selous made several journeys among the Batongas, and spent a wretched rainy season, almost without equipment, on the Manica table-land. After the rains the country looked charming. The young grass, thanks to the recent heavy rain, had shot up one foot or eighteen inches in height over hill and dale, every tree and shrub was in full leaf, and everything looked green, and fresh, and smiling. Many of the shrubs on the edge of the hills bore sweet-smelling flowers, and, as on all the plateaus of the interior of Africa, small but beautiful ground-flowers were very abundant.

Interesting observations were made on some of the northern rivers. The curious phenomenon of the steady rise of the waters of the Chobe and Machabi—an outlet of the Okavango—was observed from the first week in June until the last week in September, when they commenced to recede. That the Okavango and the Upper Kwando are connected on their upper courses, there can be little doubt, as the waters of the Machabi went on rising suddenly *pari passu* with the Chobe, until the end of September, when both commenced to recede simultaneously.

The explanation of this remarkable phenomenon is difficult, as there are no snow mountains at the sources of the Kwando and Okavango rivers and the Zambesi, which rises in the same latitude, decreases steadily in volume from day to day during the dry season like almost all other rivers in South Central Africa. Besides the channels which still become annually filled with water from the overflow of the Chobe and Okavango river systems, there are many others which are now quite dry, but in which the natives say they once used to travel in canoes.

From 1882 the journeys acquired additional geographical importance, and Mr. Selous proceeded to rectify the maps of Mashonaland laid down by earlier travellers, taking constant compass bearings, sketching the course of rivers, and fixing the position of the junction of tributaries. The value of this work was made manifest in a magnificent large scale map of the country, drawn as well as surveyed by Mr. Selous, which was used to illustrate the lecture. It would be impossible, without practically reproducing the whole address, to do justice to the immense variety and solid value of the contributions to African geography made by this most energetic of pioneers; or to the thrilling adventures, the recital of which was listened to with breathless attention and greeted with the heartiest applause. With the exception of a treacherous night attack made upon his camp by the Mashuku-sumbwe, led by a few rebel Marotse, in 1888, he had never had any other serious trouble with the natives. During his twenty years' wanderings he went amongst many tribes who had never previously seen a white man, and he was always absolutely in their power, as he seldom had more than from five to ten native servants, none of whom were ever armed.

THE DISTRIBUTION OF POWER BY ELECTRICITY FROM A CENTRAL GENERATING STATION.

ON Friday evening, the 3rd inst., Mr. A. Siemens delivered at the Royal Institution an interesting lecture on the ways in which science is applied to practice. In the course of the lecture he made the following remarks on the distribution of power by electricity from a central generating station:—

Before entering further into this, let me remind you that the earliest magneto-electric machines were used nearly sixty years ago for the production of power. I will mention only Jacobi's electric launch of 1835 as an example. It must, therefore, be considered altogether erroneous to ascribe the invention of the transmission of power to an accident at the Vienna Exhibition in 1873, when, it is said, an attendant placed some stray wires into the terminals of a dynamo machine; it began to turn, and the transmission of power was first demonstrated. As a matter of fact, Sir Wm. Siemens once informed me, that his brother Werner was led to the discovery of the dynamo-electric principle by the consideration that an electro-magnetic machine behaved like a magneto-electric machine, when a current of electricity was sent into it, viz. both turn round and give out power. It was, of course, well known that a magneto-electric machine produces a current of electricity, when turned by mechanical power, and Werner concluded that an electro-magnetic machine would behave in the same manner. We all know that he was right, but I relate this circumstance only as a further proof that the generation of power by electric currents has been a well-known fact long previous to the Vienna Exhibition.

Another well-known instance of transmission of power to a distance is furnished by the magneto-electric ABC telegraph instruments, where the motion at the sending end supplies the currents necessary to move the indicator at the receiving station.

As an illustration of the distribution of power by electricity, I will briefly describe some radical alterations that have been made at the works of Messrs. Siemens Brothers and Co., by the introduction of electric motors in the place of steam engines.

[A diagram on the wall showed in outline the various buildings in which work of different kinds is carried on with the help of different machines.]

Electric motors are supplying the power, sometimes by driving shafting to which a group of tools is connected by belting, and sometimes by being coupled direct to the moving mechanism. Each section of the works has its own meter, measuring the energy that is used there, and all of them are connected by underground cables to a central station, where three sets of engines and dynamos generate the electric current for all purposes. There are two Willans and one Belliss steam engines, each of 300 horse-power, coupled direct to the dynamos, and running at a speed of 350 revolutions per minute. Room is left for a fourth set, but including some auxiliary pumps and the switchboards for controlling the dynamos and for distributing the current, the whole space occupied by 1200 horse-power measures only 32×42 feet. Close by are the condensers and three high-pressure boilers, which have replaced some low-pressure ones formerly used for some steam engines driving the machinery in the nearest building.

The advantages that have been secured by the introduction of electric motors may be briefly stated under the following heads:—

1. Various valuable spaces formerly occupied by steam engines and boilers have been made available for the extension of workshops, and these are indicated on the diagram by shading.

2. By abolishing to a great extent the mechanical transmission of power a considerable saving is effected in motive power, which is especially noticeable at times when part only of the machinery is in use.

3. As the electric motors take only as much current as is actually required for the work they are doing, a further saving is effected, and at the same time the facility with which the speed of the motors can be altered without their interfering with each other presents a feature that is absent from mechanical transmission.

4. The big steam engines being compound and condensing, produce a horse-power with a smaller consumption of fuel than the small high-pressure steam engines scattered throughout the works.

5. The numerous attendants of the old steam engines and boilers have mostly been transferred to other work, only a few of them are required at the central station, and one or two men can easily look after all the electric motors used in the various parts of the works.

Elsewhere equally favourable results have been obtained by the introduction of electrical distribution of power, and in this respect I beg to refer you to a paper read before the German Institution of Civil Engineers by Mr. E. Hartmann in April of last year, and to a paper read by Mr. Castermans before the Society of Engineers in Liège, in August last, in which he compares in detail various methods of transmission of power, of which the electrical one was adopted for a new small arms factory.

We may therefore take it for granted that the advantages alluded to above have not resulted from local circumstances at Woolwich, but that they can be realised anywhere by the adoption of the electric current for distributing power from a central station.

At first sight this result appears to be of interest only to the manufacturer; but the development of this idea may lead to far-reaching consequences, when we consider that cheap power is one of the most important requisites for cheap production.

While power was generated by steam engines the cost of producing one-horse-power varied a good deal in the different parts, and the various owners could not have obtained their power on equal terms, those possessing the largest steam engines having a distinct advantage. This inequality is done away with altogether when the power is distributed by electricity, as the current can be supplied for large or small powers at the same rate per Board of Trade unit. It is therefore clear that the establishment of central stations for the generation of electricity on a large scale will bring about the possibility of small works competing with large works in quite a number of trades where cheap power is the first consideration.

Another circumstance favouring small works is the diminution of capital outlay brought about by the employment of electric motors. Not only are the motors cheaper than boilers and steam engines of corresponding power would be, but the outlay for belting and shafts is saved, and the structure of the building need not be as substantial as is necessary where belts and shafting have to be supported by it. A commencement has already been made in this direction by the starting of electric light stations, where the owners do all in their power to encourage the use of the current in motors, in order to keep the machinery at their central station more uniformly at work. The introduction of electricity as motive power will apparently present a strong contrast to the effect steam has had on the development of industries for the reasons already stated; and in addition there are many cases where the erection of boilers and steam engines, or even of gas engines, would be inadmissible on account of want of space or of the nuisances that are inseparable from them. Motive power will therefore be available in a number of instances where up to the present time no mechanical power could be used, but the work had to be done by manual labour or not at all.

You may have noticed that I have confined my remarks hitherto to the case of distributing electricity over a limited area, but that I have not yet discussed the question of transmitting power to a great distance.

Theoretically we have been told over and over again that the motive power of the future will be supplied by waterfalls, and that their power can be made available over large areas by means of electric currents. As a prominent example the installation is constantly mentioned by which the power of a turbine at Lauffen was transmitted over a distance of 110 statute miles to the Frankfurt Exhibition with an efficiency of 75 per cent. No doubt this result is very gratifying from a purely scientific point of view, but unfortunately in practical life only commercially successful applications of science will have a lasting influence, and in this respect the Lauffen installation left much to be desired. On the one hand science tells us that the section of the conductor can be diminished as the pressure of electricity is increased, and it appears to be only necessary to construct apparatus for generating electricity at a sufficiently high pressure so as to reduce the cost of a long conductor to reasonable limits. On the other hand, experience shows that at these high potentials the insulation of the electric current becomes a most difficult problem, and for practical purposes difficulty means an increased outlay of money.

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS MADE AT THE GOVERNMENT OBSERVATORY, BOMBAY, 1890, WITH AN APPENDIX.

THIS volume, we are informed, is the thirtieth of the series of "Bombay Magnetical and Meteorological Observations," extending the previous record from 1845 to 1889, up to 1890. At this well-organized observatory, under the direction of Mr. Charles Chambers, continuous registration of the different magnetical and meteorological elements is maintained by means of automatic recording instruments, of which there are five sets, the magnetographs (three), the barograph, the thermograph, the pluviograph, and the anemograph, all being photographic records excepting that of the anemograph, which is mechanical. In addition eye observations are also made, including the usual meteorological observations of weather and other phenomena. Daily values for 1890 are given of atmospheric pressure, temperature of the air, rainfall, wind and cloud, with some further discussion of the anemometric results; five day means of meteorological elements are also given. In the magnetic section is found observations of absolute horizontal force, magnetic declination and dip, at short intervals throughout the year. And in the appendix is contained a collection of the monthly values of declination and horizontal force from 1868 to 1890, accompanied by a discussion of the secular changes of these elements. In regard to declination the results show the eastern magnetic declination to have increased during the early years of the series, arriving at a maximum at about the middle of the period, and decreasing in the later years. Taking the annual values of declination to be represented by the formula $\delta = at^2 + bt + c$, it is found that the maximum easterly declination occurred in 1880, with value 0° 57′ 17″. This actual observation of the turning-point at this place, in the long cycle of change, is very interesting. The horizontal force values are similarly discussed, but in this case the values are generally progressive. There is no discussion of diurnal inequalities, but these were elaborately treated in a previous volume. Magnetic observatories in tropical and southern regions are valuable. Many exist in Europe with others scattered over different parts of the northern hemisphere, generally publishing with regularity their results, but there is a want of similar establishments in southern regions. There are magnetic observatories at Batavia, Mauritius, and Melbourne, but we do not get from them all that might be desired. England possesses no regularly maintained southern establishment of this kind. A magnetic observatory existed many years ago at the Cape of Good Hope, which, long since destroyed, we believe, by fire, was never again reorganized, which was unfortunate. The attention of the Magnetic Committee of the British Association was several years ago drawn to the question of re-establishing the Cape Magnetic Observatory, and in the Report of the Committee for the year 1891 it is stated that a representation had been made to the Admiralty as to the desirability of so doing. An efficient magnetic observatory in such a position, with regular publication of the results, would provide information of great value for the discussion of various questions in magnetic phenomena that now arise. It would be well also if the study of earth currents were taken up at some of the magnetic observatories in different parts of the world by continuous photographic registration thereof, for the better elucidation of the physical relation that may exist between magnetic and earth current variations, in regard to which our knowledge seems at present to be so imperfect.

BACTERIA AND BEER.

THE examination of water for micro-organisms since the publication by Koch in 1881 of his beautiful process of gelatine-plate cultures has come more and more into general use, as the public has gradually become cognisant of its value for hygienic and practical purposes. But whilst affording much valuable information on many subjects, Hansen has pointed out, as far back as 1888, that as applied to the examination of waters for brewing purposes it cannot be considered wholly satisfactory. Working on lines suggested by Hansen, Holm has recently published a paper, "Analyses biologiques et zymotechniques de l'eau destinée aux brasseries" (*Compte-rendu des travaux du laboratoire de Carlsberg*, vol. iii., Copenhagen, 1892), in which he describes a large number of investigations on brewing-waters examined by Hansen's method, and in which the relative merit for brewing purposes of Koch's and Hansen's processes is also discussed. It is obvious that the organisms to be feared in a brewery are those which will flourish in wort or beer, and that the mere knowledge of the number of bacteria in any given water as revealed by gelatine plate cultures is but of little use. Hence Hansen and his pupils reject for such examinations gelatine-peptone, substituting sterilised wort and beer as a culture material. An interesting table is given showing the different bacteriological results obtained in the use of gelatine-peptone, gelatine to which wort had been added, wort alone, and beer. For example, whereas a particular brewing-water yielded by gelatine-peptone about 8000 colonies per c.c., the majority of which were bacteria; gelatine mixed with wort gave about 14, all being moulds; in wort 5·4 were found, consisting of bacteria and moulds, whilst sterilised beer gave only 0·8 for the c.c., and only moulds. Holm points out that to estimate the value of a water for brewing purposes a note should also be made of the rate at which the organisms develop in the wort or beer, for should signs of growth only declare themselves after four or five days in the laboratory under favourable conditions of temperature and in the absence of competing forms, it is not unnatural to expect that their vitality, under the more rigorous conditions imposed during brewing operations, would be so far impaired that their development, if taking place at all, would only be accomplished with great difficulty. Although instances occurred in which even after the lapse of seven days growths first made their appearance, yet in the majority of cases the incubation of the wort-flasks for one week was sufficient. Holm is of opinion that the use of other culture materials besides wort is unnecessary, as all the organisms which successfully develop in beer can also grow in wort. Moreover, it was found that in the process of sterilisation to which the beer was submitted a considerable proportion of its alcohol was lost, thus diminishing its natural bactericidal properties. A beer containing 5 to 6 per cent. of alcohol, after sterilisation, had this reduced to 2·8 per cent., although it even then proved a very unfavourable medium for the development of ordinary water bacteria. As a practical outcome of his experiments Holm emphasises the necessity of a careful selection of the site for the erection of the water-reservoir attached to a brewery. The reservoirs of the old brewery at Carlsberg are placed in the immediate vicinity of the storehouses for grain and malt, consequently in this water a far larger number of moulds were met with than in the water examined from differently situated reservoirs supplying the laboratory and another brewery. But although moulds usually predominate, yet they are not so much to be feared as the bacteria, more especially those which are found in the fermentation chamber, for although they are unable to assert themselves to any considerable extent in the beer preserved in the store cellar, yet when it is drawn off and thus aërated, and the temperature raised by its transference to bottles or small casks, these organisms can develop with an astonishing rapidity, and produce great mischief.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Shore, of St. John's College, late Examiner in Physiology, has been elected a member of the Special Board for Medicine; Dr. A. Macalister, F.R.S., St. John's, has been appointed an elector to the Professorship of Chemistry; Dr. Ferrers, F.R.S., Master of Gonville and Caius, an elector to the Plumian Professorship of Astronomy; Prof. Newton, F.R.S., Magdalene, an elector to the Professorship of Anatomy; Dr. Phear, Master of Emmanuel, an elector to the Professorship of Botany; Dr. R. D. Roberts, Clare, an elector to the Woodwardian Professorship of Geology; Mr. P. T. Main, St. John's, an elector to the Jacksonian Professorship of Chemistry, &c.; Mr. R. T. Glazebrook, F.R.S., Trinity, an elector to the Professorship of Mineralogy; Mr. F. Darwin, F.R.S., Reader in Botany, an elector to the Professorship of Zoology and Comparative Anatomy; Mr. W. D. Niven, F.R.S., Trinity, an elector to the Cavendish Professorship of Physics; Dr. Phear, an elector to the Professorship of Mechanism; Prof. Liveing, F.R.S., St. John's, an elector to the Downing Professorship of Medicine; Dr. P. H. Pye-Smith, F.R.S., an elector to the Professorship of Physiology; and Sir G. M. Humphry, F.R.S., an elector to the Professorship of Pathology.

SCIENTIFIC SERIALS.

American Journal of Science, February.—Isothermals, isopiestics, and isometrics relative to viscosity, by C. Barus. The substance experimented upon was marine glue, and its viscosity at different pressures and temperatures was measured by a transpiration method, the substance being forced through steel tubes 10 cm. long and 0·5 to 1 cm. in diameter under pressures as high as 2000 atmospheres. It was found that in proportion as the viscosity of a body increases with fall of temperature, its isothermal rate of increase with pressure also increases. Speaking approximately, the rate at which viscosity increases with pressure at any temperature is proportional to the initial viscosity at that temperature, and, conversely, the rate of decrease with temperature is proportional to the actual temperature and independent of the pressure. An interesting result is that in high pressure phenomena at least 200 atmospheres must be allowed per degree Centigrade, in order that there may be no change of viscosity.—"Potential," a Bernoullian term, by Geo. F. Becker.—Datolite from Loughboro, Ontario, by L. V. Pirsson.—A new machine for cutting and grinding thin sections of rocks and minerals, by G. H. Williams.—Stannite and some of the alteration products from the Black Hills, S.D., by W. P. Headden.—Occurrence of hematite and martite iron ores in Mexico, by R. T. Hill, with notes on the associated igneous rocks, by W. Cross.—Cæsium lead and potassium-lead halides, by N. L. Wells.—Ceratops beds of Converse County, Wyoming, by J. B. Hatcher.—Use of planes and knife-edges in pendulums for gravity measurements, by T. C. Mendenhall. The employment of a pendulum to which the plane is attached instead of the knife-edge presents several advantages. The plane may be accurately adjusted at right angles to the rod by simple optical methods. A pendulum carrying a plane instead of a knife-edge is vastly less liable to injury, and the knife-edge being no longer an integral part of the vibrating mass can be reground or replaced at will. The length of the pendulum is more capable of accurate determination, since the error introduced by the yielding of the edge under pressure is eliminated. The disadvantage due to the uncertain position of the axis of oscillation can be mechanically got rid of by a proper construction of the raising and lowering apparatus, and experiment shows that the period in the course of twelve sets of swings of an hour each does not vary by as much as one part in a million. The best angle for the knife-edge was found to be about 130°, the material used being agate.—Preliminary note on the colours of cloudy condensation, by C. Barus. If saturated steam is allowed to pass suddenly from a higher to a lower temperature in uniformly temperatured, uniformly dusty air, a succession of colours is seen by transmitted white light which, taken in inverse order, are absolutely identical with the colours of Newton's rings of the first two orders.—Lines of structure in the Winnebago Co. meteorites and in other meteorites, by H. A. Newton (reprinted in this issue).—Preliminary note of a new meteorite from Japan, by Henry A. Ward.—Restoration of Anchisaurus, by O. C. Marsh (see Note, p. 349).

American Journal of Mathematics, vol. xiv. No. 4 (Baltimore, 1892).—The main object of the note on the use of supplementary curves in isogonal transformation, by R. A. Harris (pp. 291–300), is to show how the problem of representing one plane conformably upon another, using any real function of the variable, may be made to depend upon the problem of constructing supplementary curves from given tracings of the corresponding principal curves. It is well illustrated by four carefully drawn figures. In her memoir (pp. 301–325) on the higher singularities of plane curves, Miss C. A. Scott goes over ground to some extent previously occupied by Profs. Cayley and H. J. S. Smith in writing on the same subject (*cf.* also papers by Brill and Nöther in the *Math. Annalen*, vols. ix. xvi. xxiii.). Nöther's results are presented in analytical form, "involving no dependence on geometrical ideas even when geometrical terms are used." The author brings out his results more clearly by making use of Dr. Hirst's method of quadric inversion. The text is accompanied by twenty-seven drawings of curves. Mr. W. H. Metzler, writing on the roots of matrices (pp. 326–377), employs a modification of Dr. Forsyth's method of proving Cayley's "identical equation" ("Messr. of Mathematics," vol. xiii.) to prove Sylvester's law of latency and Sylvester's theorems. He also investigates the existence of roots of matrices for different indices, and in particular the roots of nilpotent matrices. A careful analysis of the contents is prefixed to the memoir. Dr. F. N. Cole (pp. 378–388) discusses the simple groups from order 201 to order 500, and arrives at the conclusion that "the possible orders of simple groups of compound order between 201 and 500 are reduced to 360 and 432." The volume closes with a note (p. 389) by M. M. D'Ocagne, correcting a slight mistake in a memoir by him in the 1888 volume, entitled "Sur certaines courbes," and the title page and index.

SOCIETIES AND ACADEMIES.

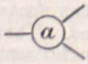
LONDON.

Royal Society, February 2.—"On a Meteoric Stone found at Makariwa, near Invercargill, New Zealand." By G. H. F. Ulrich, Professor of Mining and Mineralogy in the University of Dunedin, N.Z. Communicated by Prof. J. W. Judd, F.R.S.

The specimen described in this memoir was found in the year 1879 in a bed of clay, which was cut through in making a railway at Invercargill, near the southern end of the Middle Island of New Zealand. Originally, this meteorite appears to have been about the size of a man's fist, and to have weighed four or five pounds, but it was broken up, and only a few small fragments have been preserved. The stone evidently consisted originally of an intimate admixture of metallic matter (nickel-iron) and of stony material, but much of the metallic portion has undergone oxidation. Microscopic examination of thin sections shows that the stony portion, which is beautifully chondritic in structure, contains olivine, enstatite, a glass, and probably also magnetite; and through these stony materials the nickel-iron and troilite are distributed. The specific gravity of portions of the stone was found to vary between 3·31 and 3·54, owing to the unequal distribution of the metallic particles. A partial chemical examination of this meteorite was made by the author and Mr. James Allen, but the complete analysis has been undertaken by Mr. L. Fletcher, F.R.S., of the British Museum. The analysis, which when finished will be communicated to this Society, has gone so far as to show that the percentage mineral composition of the Makariwa meteorite may be expressed approximately by the following numbers: nickel-iron 1, oxides of nickel and iron 10, troilite 6, enstatite 39, olivine 44.

Physical Society, January 27.—Walter Baily, Vice-President, in the chair.—Prof. S. P. Thompson, F.R.S., made a communication on Japanese magic mirrors, and exhibited numerous specimens showing the magic properties. Referring to the theory of the subject, he said the one now generally accepted was that proved by Profs. Ayrton and Perry in 1878, who showed that the patterns seen on the screen were due to differences in curvature of the surface. The experiments he now brought forward fully confirmed their views. Brewster had maintained that the effects were due to differences of texture in the surfaces causing differences in absorption or polarisation, but the fact that the character of the reflected image depended on the convergency or divergency of the light, and on the position of the screen, showed this view to be untenable. Another proof of the differing curvature theory was then given by covering a Japanese mirror with a card having a small hole in it. On moving the card about, the disc of light reflected from the exposed portion varied in size, showing that the curvatures of portions of the surfaces were not the same. The same fact was proved by a small spherometer, and also by reflecting the light passing through a coarse grating from the mirror, the lines being shown distorted. To put the matter to a test demanded by Brewster, he had a cast taken from a mirror by his assistant, Mr. Rousseau; this had been metallised, silvered, and polished, and now gave unmistakable evidence of the pattern reflected from the original. The true explanation of how the inequalities of curvature were brought about during manufacture had also been given by Profs. Ayrton and Perry, but there were some questions of detail on which difference of opinion might exist. The late Prof. Govi had noticed that warming a mirror altered its possibilities. A thick mirror which gave no pattern whilst cold developed one on being heated, was shown to the meeting. Prof. Thompson also showed that a glass mirror having a pattern cut on the back developed magic properties when the mirror was bent. When made convex the reflected pattern was dark on a light ground, and when made concave, light on a dark ground. Warming ordinary mirror-glass by a heater whose surface was cut to a pattern gave similar effects. Very thick glasses could be affected in this way. On passing a spirit lamp behind a strip of mirror, a dark band could be caused to pass along the screen illuminated by light reflected from the mirror. By writing on lead foil and pressing the foil against a glass mirror by a heater, the writing was caused to appear on the screen. Prof. Thompson had also found that Japanese mirrors which are not "magic" when imported, could be made so by bending them mechanically so as to make them more convex. In conclusion, he showed a large mirror 15″ × 11″, the reflection from which showed the prominent parts of the pattern on its back with the exception of two conspicuous knobs; these knobs gave no indication of their existence. Prof. Ayrton said the simple mechanical production of the magic property described by Prof. Thompson led him to think that some experiments on "seeing by electricity" by the aid of selenium cells which Prof. Perry and himself made some years ago, might lead to some result if repeated with thinner reflectors. Speaking of the effect of scratching the back of a Japanese mirror, he pointed out that if metal be removed by pressure a bright image was seen, whilst if removed chemically a dark image resulted. Since the original paper on the subject was written he had been led to modify his views as to the effect of amalgamation, for some time ago he showed the society how brass bars were bent if one edge be amalgamated, thus proving that enormous forces were developed. He now regarded amalgamation as an important part of the manufacture. Mr. Trotter inquired if it had been proved that there was no difference in the metal in the thick and thin parts? One would expect the thin parts to be harder and polished away less. After some remarks by Mr. J. W. Kearton and Major Rawson, Prof. Thompson said the magic effects produced by heating the back of a glass mirror remained for a short time after the heater was removed. The question of whether differences in hardness of the thick and thin parts of a mirror were of consequence in the production of the magic property had been tested by using sheets of brass thickened by pieces soldered to the back as mirrors, and found to be unimportant. Prof. Ayrton also described an experiment pointing to the same conclusion.—Mr. W. F. Stanley read a paper on the functions of the retina—(i.) The Perception of Colour. Referring to Young's three-nerve theory of colour-sensation, the author said Prof. Rutherford had pointed out that there was no necessity to assume that different nerves conveyed different colour-sensations, for as a telephone wire would transmit almost an infinite variety of sound vibrations, so the nerves of the retina were probably equally capable of conveying all kinds of light vibrations. Prof. Rutherford had further pointed out that the image of a star could not possibly cover three nerve-terminals at once, and therefore could not be seen as white if Young's theory was correct. The author then described Helmholtz's experiments with a small hole in a screen illuminated by spectrum colours. For red illumination the greatest distance at which the hole could be seen sharply defined was 8 feet, and for violet 1½ feet. When the hole was covered with purple glass, or with red and violet glasses superposed, and a bright light placed behind, the eye, when accommodated for red light, saw a red spot with a violet halo round it, and when focussed for violet light, saw a violet spot with circle of red. These experiments the author thinks show that the chromatic sense in distinct vision under critical conditions (*i.e.* where a single nerve or a small group of nerves is concerned) depends on the colours being brought to foci at different distances behind the crystalline lens. He also infers that the same focal position in the eye cannot convey simultaneously the compound impression of widely separated colours. Helmholtz's observations are further examined in the paper, and a series of zoetrope and colour disc experiments described which tend to show that the eye cannot follow rapid changes of colour. Changes from red to violet could be followed much more quickly than from violet to red. The red impressions were, however, more permanent. The observed effects were found to depend on the intensity of the light, and also on the distance of the eye from the coloured surface. Summing up his observations, the author infers that by systems of accommodation of the eye, the colours of the spectrum are brought to focus on special parts or points of the rods or cones of the retina, such focal points being equivalent, by equal depths or distances from the crystalline lens, to a focal plane formed across the whole series of nerve-terminals. That all the rays of light from an object, or part of an object, of very small area and of any spectrum colour, will converge to a point upon a nerve terminal, and that this terminal will be most excited by the light. At the end of the paper Dr. Stanley Hall's views of nerve structure are examined. Captain Abney thought the results of the zoetrope experiments were what one would have expected when pigmentary colours were used. To be conclusive, such experiments must be conducted with pure spectrum colours. The statement about the size of star images being less than that of a nerve terminal would probably need revision. Speaking of colour vision, he said the modern view was to regard light as producing chemical action in the retina, which action gave rise to the sensation of colour. On the author's theory he could not see how colour-blindness could be explained. Mr. Trotter said he understood Helmholtz to have proved that nerves could distinguish quantity, but not the quality of a stimulus. Since the speed at which stimuli travelled to the brain was about 30 metres a second, the wave length of a light vibration, if transmitted in this way, would be very small. Taking Lord Kelvin's estimate of the minimum size of molecules of matter, it followed that there must be many wave lengths in the length of a single molecule. This, he thought, hardly seemed possible. Mr. Lovibond pointed out that the observations referred to by the author could be equally well explained on the supposition that six colour sensations existed. The confusion of colours he had mentioned arose from lack of light. Mr. Stanley replied to some of the points raised by Captain Abney. In proposing a vote of thanks to Mr. Stanley, the chairman said it had been shown that light could be resolved into three sensations, but it was not known how this resolution occurred. Prof. S. P. Thompson said the gist of Mr. Stanley's paper seemed to be that lights of different colours were concentrated at points situated at different depths in the retina, the violet falling on the part nearest the crystalline lens, and the red furthest away. Another view of the action was that the different sensations might be due to the vibrations of longer wave length having to travel greater distances along the nerve terminals before they were completely absorbed.

Mathematical Society, January 12.—Mr. A. B. Kempe, F.R.S., President, in the chair.—The President (Prof. Elliott, F.R.S., Vice-President, in the chair) read a paper on the application of Clifford's graphs to ordinary binary quantics (second part). In the first part it was pointed out that by some small modifications and a recognition of the fact that the covariants of $f(x, y)$ are invariants of the two quantics $f(X, Y)$ and $(Xy - Yx)$, the theory of graphs, which had been left in an unfinished state by the late Prof. Clifford, furnished a complete method of graphically representing the invariants (and therefore the covariants) of binary quantics. The method as modified depends essentially on the fact that any invariant, when multiplied by a suitable number of polar elements U, U′, V, V′, &c., can be expressed as a "pure compound form" (or sum of two or more such forms), the product of a number of "simple forms." Each of the latter has a "mark," viz. one of the letters *a*, *b*, *c*,…… and has also a certain valence, 0, 1, 2, 3, &c. and these being given it is fully defined, *e.g.*, the simple form of mark *a* and valence 3 is graphically



having three radiating bonds, and is algebraically

$$a_0\,UVW + a_1\,(U'VW + UV'W + UVW') + a_2(UV'W' + U'VW' + U'V'W) + a_3\,U'V'W',$$

the pairs of polar elements U, U′; V, V′; and W, W′, corresponding to the three bonds of the graphical representation. A pure compound form is graphically represented by a number of simple forms having their bonds connected so that there are no free ends. If in the algebraical expression of a compound form two simple forms both contain the pair of polar elements U, U′, there will be a bond connecting their graphical representations; if the two simple forms both contain two pairs of such elements, viz. U, U′ and V, V′, there will be two bonds connecting their graphical representations and so on; if they contain no common pair their graphical representations will have bond connecting them. A pair of polar elements will appear in two simple forms only, so that each bond in the graphical representation of a compound form corresponds to a distinct pair of polar elements. If the algebraical expression corresponding to a graph be multiplied out, it will be found to consist of two distinct factors, viz. :—(1) the product of all the polar elements, and (2) a function of the letters $a_0, a_1, a_2 \ldots\ldots$; $b_0, b_1, b_2, \ldots\ldots$; &c., &c.; corresponding to the marks *a*, *b*, ……&c. of the simple forms contained in the compound form represented by the graph, the latter factor being an invariant of the quantics

$$(a_0, a_1, a_2, \ldots\ldots\ldots a_\alpha)(x, y)^\alpha$$
$$(b_0, b_1, b_2, \ldots\ldots\ldots b_\beta)(x, y)^\beta$$
&c., &c.

where α is the valence of the simple forms of mark *a*, which are here supposed to be all of the same valence, and similarly in the case of β, γ, &c.

In this second part a method of algebraically representing invariants is considered, which is directly derivable from the method of the first part, and was suggested by the graphs; but differs essentially from the earlier method in that it is independent of the use of polar elements. It shows, moreover, that the graphs may be regarded as absolutely equivalent to the invariants they represent, in lieu of being equivalent to those invariants multiplied by a number of polar elements. This second method deals in the first instance with "primary" invariants, *i.e.* invariants of two or more quantics linear in the coefficients of each. If these quantics are

$$(a_0, a_1, a_2, \ldots\ldots\ldots a_\alpha)(x, y)^\alpha$$
$$(b_0, b_1, b_2, \ldots\ldots\ldots b_\beta)(x, y)^\beta$$
&c., &c.,

and we take

$$a = a_1\frac{d}{da_0} + a_2\frac{d}{da_1} + a_3\frac{d}{da_2} + \text{\&c. } \textit{ad infinitum.}$$

$$b = b_1\frac{d}{db_0} + b_2\frac{d}{db_1} + b_3\frac{d}{db_2} + \text{\&c. } \textit{ad infinitum.}$$
&c., &c.

we may express any primary invariant by an expression, or the sum of two or more expressions, consisting of the product of differences of the operators *a*, *b*,….. operating upon the product of the corresponding leading terms, a_0, b_0, &c. Thus

$$(a-b)^2 a_0 b_0 \equiv a_2 b_0 - 2a_1 b_1 + a_0 b_2$$

is an invariant of the two quantics

$$a_0x^2 + 2a_1xy + a_2y^2,$$
$$b_0x^2 + 2b_1xy + b_2y^2,$$

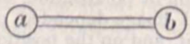
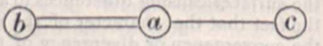
linear in the coefficients of each; and

$$(a-b)^2(a-c)a_0b_0c_0 \equiv a_3b_0c_0 - a_2b_0c_1 - 2a_2b_1c_0 + 2a_1b_1c_1 + a_1b_2c_0 - a_0b_2c_1$$

is a similar invariant of the three quantics

$$a_0x^3 + 3a_1x^2y + 3a_2xy^2 + a_3v_1^3$$
$$b_0x^2 + 2b_1xy + b_2y^2$$
$$c_0x + c_1y.$$

These two invariants are graphically represented by

 and 

respectively, where the relation between the algebraical and graphical expressions is obvious, viz. to every letter *p* in the algebraical representation there corresponds a nucleus including the mark *p*, and to every factor $(p-q)$ in the algebraical representation there corresponds a bond connecting the nuclei of marks *p* and *q*.

We can pass to invariants of higher degrees in the coefficients of the various quantics by substituting like coefficients for unlike. Thus, if we make $b_0 = a_0$, $b_1 = a_1$, $b_2 = a_2$, the primary invariant

$$a_2b_0 - 2a_1b_1 + a_0b_2$$

becomes the invariant of degree 2

$$2(a_0a_2 - a_1^2)$$

of the single quantic

$$a_0x^2 + 2a_1xy + a_2y^2.$$

This invariant will be graphically represented by substituting the mark *a* for the mark *b* in the graph representing the corresponding primary invariant.

If we proceed to deal in the same way with the invariant,

$$a_3b_0c_0 - a_2b_0c_1 - 2a_2b_1c_0 + 2a_1b_1c_1 + a_1b_2c_0 - a_0b_2c_1,$$

we get, as the invariant represented by substituting for the marks *b* and *c* the mark *a*, the expression of the third degree,

$$a_3a_0^2 - 3a_2a_1a_0 + 2a_1^3.$$

This is not an invariant of a single quantic, but of the three

$$a_0x^3 + 3a_1x^2y + 3a_2xy^2 + a_3y^3$$
$$a_0x^2 + 2a_1xy + a_2y^2$$
$$a_0x + a_1y.$$

It bears, however, a definite relation to the first of these three quantics, viz.: it is a *seminvariant* of that quantic, being in fact the source of its cubic-covariant J. The paper points out that all seminvariants are thus invariants of two or more quantics, and can therefore be represented by graphs; the difference between a graph representing an invariant of a quantic and one representing a seminvariant of the same quantic consisting merely in this, that the simple forms, *i.e.* the small circles or nuclei of the graphs in the former case are all of the same "valence," *i.e.* have the same number of bonds, while in the latter, though of like marks, they differ in valence. The classification of seminvariants, according to the valences of the simple forms composing them, or, in other words, according to the orders of the quantics of the systems of which they are respectively invariants, obviously throws considerable light upon their structure.

The paper also deals with the breaking up of graphs into simpler ones; and gives a theorem upon the subject which leads to some interesting results. It points out, moreover, how the graphs representing the sources of covariants can be instantaneously derived from those representing the covariants themselves.

On the evaluation of a certain surface-integral and its application to the expansion of the potential of ellipsoids in series, Dr. Hobson.

On the vibrations of an elastic circular ring, by Mr. A. E. H. Love.—The ring is supposed to be of small circular section of radius c, and the elastic central-line a circle of radius a. There are four ways of displacing the ring. A point on the central-line may move along the radius of the circle which is its primitive form, or perpendicular to the plane of this circle, or along the tangent to this circle; and the circular sections may be displaced by rotation about the central-line. The modes of vibration fall into four classes, of which two are physically important:—Class I. Flexural vibrations in plane of ring.—These were investigated by Hoppe in 1871 (*Crelle*, bd. lxxiii.). The motion of a point on the elastic central-line is compounded of a displacement in and out along the radius and a displacement along the tangent to the circle, so proportioned that the central-line remains unstretched, and the nodes of the former displacement are the antinodes of the latter. There must be at least two wave-lengths to the circumference, and the frequency ($p/2\pi$) of the mode in which there are n wave-lengths to the circumference is given by the equation

$$p^2 = \frac{1}{4}\frac{n^2(n^2-1)^2}{n^2+1}\frac{E}{\rho_0}\frac{c^2}{a^4}$$

in which E is the Young's modulus, and ρ_0 the density of the material. Except for the numerical coefficient this is precisely similar to the formula for the lateral vibrations of a straight bar of the same material and section and of length πa (for which the fundamental tone has the same wave-lengths). The sequence of component tones when n is very great is ultimately identical with that of the tones of a free-free bar of length πa, but the sequence for the low tones is quite different to that for a bar. Class II. Flexural vibrations perpendicular to the plane of the ring.—It is found to be impossible to make the ring vibrate freely so that each particle of the elastic central-line moves perpendicular to the plane of the ring, unless at the same time the sections turn about the central-line through a certain angle. The flexure perpendicular to the plane of the ring is always accompanied by *torsion*. As in Class I. there must be at least two wave-lengths to the circumference, and the frequency of the mode in which there are n wave-lengths to the circumference is given by the equation

$$p^2 = \frac{1}{4}\frac{n^2(n^2-1)^2}{1+\sigma+n^2}\frac{E}{\rho_0}\frac{c^2}{a^4}$$

where σ is the *Poisson's ratio* for the material and the other constants have the same meaning as before. (For most hard solids σ is about $\frac{1}{4}$.) Since n must be at least 2 the sequence of tones is very nearly the same as in the vibrations of Class I., but the pitch is slightly lower, the ratio of the frequencies for the gravest tones being $\sqrt{\frac{21}{20}}$, which is very little less than a *comma*. For the higher tones, as we should expect, there is no sensible difference. These two classes include all that have much physical importance. The remaining types can be classified as:—Class III. Extensional vibrations.—The motion may be purely radial or partly radial and partly tangential. In the second case there will be an integral number of wave-lengths, and when this number is n we have the formula for the frequency

$$p^2 = (1 + n^2)\frac{E}{\rho_0}\frac{1}{a^2}$$

Putting n = zero we find the frequency of the purely radial vibrations. The pitch of any mode of extensional vibration of the ring is of the same order of magnitude as the pitch of the corresponding longitudinal vibration of a bar of length equal to half the circumference, the formula for the latter being in fact derived by writing n^2 for $1 + n^2$. Class IV. Torsional vibrations.—The motion consists of an angular displacement of the sections about the elastic central-line accompanied by a relatively very small displacement of the points on this line perpendicular to the plane of the ring. When there are n wave-lengths to the circumference the frequency is given by the formula

$$p^2 = (1 + \sigma + n^2)\frac{\mu}{\rho_0}a^2,$$

in which μ is the *rigidity* of the material. There is one symmetrical mode for which n is zero, and since $2\mu(1 + \sigma) = E$, the frequency of this mode is $\frac{1}{2}\sqrt{2}$ of that of the radial vibrations. The pitch of the torsional vibrations is comparable with that for a straight rod of length equal to half the circumference, the formula for the latter being in fact derived by writing n^2 in place of $1 + \sigma + n^2$. Formulæ equivalent to those given in connection with Classes II. and IV. have been obtained by Mr. Basset (Proc. Dec. 1891), but he has not interpreted his results.

Entomological Society, February 8.—Mr. Henry John Elwes, president, in the chair.—The President announced that he had nominated Mr. F. DuCane Godman, F.R.S., Mr. Frederic Merrifield, and Mr. George H. Verrall as Vice-Presidents during the Session 1893–1894.—Mr. S. Stevens exhibited a specimen of *Chœrocampa celerio*, in very fine condition, captured at light, in Hastings, on September 26 last, by Mr. Johnson.—Mr. A. J. Chitty exhibited specimens of *Gibbium scotias* and *Pentarthrum huttoni*, taken by Mr. Rye in a cellar in Shoe Lane. He stated that the *Gibbium scotias* lived in a mixture of beer and sawdust in the cellar, and that when this was cleaned out the beetles disappeared. The *Pentarthrum huttoni* lived in wood in the cellar.—Mr. McLachlan exhibited a large Noctuid moth, which had been placed in his hands by Mr. R. H. Scott, F.R.S., of the Meteorological Office. It was stated to have been taken at sea in the South Atlantic, in about lat. 28° S., long. 26° W. Colonel Swinhoe and the President made some remarks on the species, and on the migration of many species of Lepidoptera.—Mr. W. F. H. Blandford exhibited larvæ and pupæ of *Rhynchophorus palmarum*, L., the Gru-gru Worm of the West Indian Islands, which is eaten as a delicacy by the Negroes and by the French Creoles of Martinique. He stated that the existence of post-thoracic stigmata in the larva of a species of Rhynchophorus had been mentioned by Candèze, but denied by Leconte and Horn. They were certainly present in the larva of *R. palmarum*, but were very minute.—Mr. G. T. Porritt exhibited two varieties of *Arctia lubricipeda* from York; an olive-banded specimen of *Bombyx quercus* from Huddersfield; and a small melanic specimen of *Melanippe hastata* from Wharncliffe Wood, Yorkshire.—Mr. H. Goss exhibited species of Lepidoptera, Coleoptera, and Neuroptera, sent to him by Major G. H. Leathem, who had collected them, last June and July, whilst on a shooting expedition in Kashmi territory, Bengal. Some of the specimens were taken by Major Leathem at an elevation of from 10,000 to 11,000 feet, but the majority were stated to have been collected in the Krishnye Valley, which drains the glaciers on the western slopes of the Nun Kun range. Mr. Elwes remarked that some of the butterflies were of great interest.—Mr. G. F. Hampson exhibited a curious form of *Parnassius*, taken by Sir Henry Jenkyns, K.C.B., on June 29 last, in the Gasternthal, Kandersteg.—Mr. J. M. Adye exhibited a long series of remarkable varieties of *Boarmia repandata*, taken last July in the New Forest.—Mr. C. O. Waterhouse exhibited a photograph of the middle of the eye of a male *Tabanus*, showing square and other forms of facets, multiplied twenty-five times.—Mr. R. Trimen, F.R.S., communicated a paper entitled "On some new, or imperfectly known, species of South African

Butterflies," and the species described in this paper were exhibited.—Mr. T. D. A. Cockerell communicated a paper entitled "Two new species of *Pulvinaria* from Jamaica."—Mr. Martin Jacoby communicated a paper entitled "Descriptions of some new genera and new species of Halticidæ."

Linnean Society, February 2.—Prof. Stewart, President, in the chair.—On behalf of Mr. Thomas Scott, the Secretary read a report on the entomostraca from the Gulf of Guinea, collected by Mr. John Rattray.—Mr. H. Bernard gave an account of two new species of *Rhax*.—An important paper by Mr. Arthur Lister, on the division of nuclei in the mycetozoa, gave rise to an interesting discussion, in which Dr. D. H. Scott, Prof. Howes, and others took part.—This was followed by a paper on the structural differentiation of the protozoan body as studied in microscopic sections, by Mr. J. E. Moore. The meeting adjourned to February 16.

PARIS.

Academy of Sciences, February 6.—M. de Lacaze-Duthiers in the chair.—On the variations in the intensity of terrestrial gravitation, by M. d'Abbadie. Observations begun in 1837 at Olinda (Brazil), on the variations in the direction of gravitational force also made its constancy doubtful. Experiments on falling bodies revealed irregularities similar to those described (last number) by M. Mascart. The closed barometer employed by the latter may be termed a *brithometer*.—On the preparation of carbon under high pressure, by M. Henri Moissan (see article).—On the reproduction of the diamond, by M. C. Friedel. Remarks by M. Berthelot (see article).—On the pathogeny of diabetes; part played by the expenditure and the production of glycose in the deviations of the glycemic function, by MM. A. Chauveau and Kaufmann. The same inferiority of venous with respect to arterial blood, as regards the amount of sugar contained in it, occurs in all the deviations of the glycemic function produced by a lesion of the central nervous system. This inferiority is equally pronounced in the hyperglycemia resulting from the extirpation of the pancreas.—On the progress of the art of surveying with the aid of photography, in Europe and America, by M. A. Lausedat. Since 1888 a zone of twenty miles on each side of the Canadian Pacific Railway, in the neighbourhood of the Canadian National Park, has been surveyed with the aid of photography under the direction of Messrs. Deville, Drewry, and McArthur, at an average rate of 1040 square km. per annum for four men under great climatic disadvantages. The cost of the undertaking amounts to three dollars per square km.—Determination of the amount of carbonic oxide which can be contained in confined air, by means of a bird employed as physiological reagent, by M. N. Gréhant.—On the properties of faculæ; reply to a note by Mr. G. Hale, by M. H. Deslandres.—The probability of coincidence between solar and terrestrial phenomena, by M. G. E. Hale.—Note on an explicit expression of the algebraic integral of a hyperelliptic system of the most general form, by M. F. de Salvert.—On a generalisation of Bertrand's curves, by M. Alphonse Dumoulin.—On the surfaces which admit a system of lines of spherical curvature and which have the same spherical representation for their lines of curvature, by M. Blutel.—On semicircular interference fringes, by M. G. Meslin. Rectilinear interference fringes are sections of hyperboloids by planes parallel to their axis, the light being propagated in a direction at right angles to that axis. If the light proceeds along the axis, a screen perpendicular to it will cut circular sections, and the fringes will have the form of a circumference of which a greater or smaller arc will be seen accordingly as the two pencils overlap more or less. In practice these circular fringes were obtained by separating two of Bellet's half lenses and placing them one before the other in front of a very small hole illuminated by sunlight, such that the axis of the pencil passes through the optical centre of the two lenses. Under these conditions two pencils are formed from the same source of light, which may be made to show circular fringes by moving the lenses slightly in a direction perpendicular to their optical axes.—Study of the fluorides of chromium, by M. C. Poulenc.—On a new soldering process for aluminium and various other metals, by M. J. Novel. For aluminium the following solders are recommended: (1) Pure tin, fuses at 250°. (2) Pure tin 1000 gr.; lead 50 gr. (280° to 300°). (3) Pure tin 1000 gr.; pure zinc 50 gr. (280° to 320°). These solders do not stain or attack aluminium. A nickel soldering bit is preferable. (4) Pure tin 1000 gr.; red copper 10 to 15 gr. (350° to 450°). (5) Pure tin 1000 gr.; pure nickel 10 to 15 gr. (350° to 450°). These give a slightly yellowish tint, but are very durable. (6) Pure tin 900 gr.; copper 100 gr.; bismuth 2 to 3 gr. This is specially suitable for soldering aluminium bronze.—Action of acetic acid and formic acid upon terebenthine, by MM. Bouchardat and Oliviers.—On the mode of elimination of carbonic oxide, by M. L. de Saint-Martin. Experiment shows that animals partly intoxicated by carbonic oxide, when placed in conditions under which natural elimination is impossible, destroy slowly but regularly a certain quantity of the poisonous gas, this destruction being the more active the less the intoxication. It is probably converted into carbon dioxide. The toxic effect is entirely dependent upon the time during which the organism is exposed to the gas, and a very small quantity can be fatal on prolonged exposure.—Influence of pilocarpine and floridzine on the production of sugar in milk, by M. Cornevin.—On the seat of the colouring matter in the green oyster, by M. Joannes Chatin.—On pseudo-fertilisation in the *Uredinei*, by MM. P. A. Dangeard and Sapin-Trouffly.—On the substances formed by the nucleole in *Spirogyra setiformis*, and the directive force which it exerts upon them at the moment of the division of the cellular nucleus, by M. Ch. Decagny.—On a process for measuring the double refraction of crystalline plates, by M. Georges Friedel.—A horizontal section of the French Alps, by M. W. Kilian.—On the arrangement of the cretaceous beds in the interior of the Aquitaine basin, and their relations to tertiary formations, by M. Emmanuel Fallot.

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