THURSDAY, JULY 31, 1890.

LAVOISIER.

La Révolution Chimique : Lavoisier. Par M. Berthelot. (Paris : Félix Alcan, 1890.)

AMONGST the crop of literature which the centenary of the French Revolution has produced, there are probably no works more interesting to the historian of science in general, and certainly none more interesting to the historian of chemistry in particular, than the two biographies of Lavoisier which then appeared, the one due to the patient industry of M. Grimaux, and the other to the patriotic zeal of M. Berthelot. These works have necessarily much in common, but they differ essentially in the standpoint from which their authors regard their subject. M. Grimaux's book was the first to make its appearance. It deals more especially with the public life of Lavoisier, with his work as a *fermier-général* and at the *Régie des Poudres*, and with his labours as an economist and as a social and political reformer. To a reader but little versed in the history of science the general tendency of M. Grimaux's work is to place in high relief the political side of Lavoisier's career; and to magnify the servant of the State at the expense of the chemist. Hence it was but proper and natural that M. Berthelot, the Perpetual Secretary of the Academy, should have felt urged to set forth in a clearer light the nature of the service which his illustrious predecessor, who fought so nobly for the Academy during the dark days of the Great Terror, has rendered to science. M. Berthelot has accordingly occupied himself almost exclusively with the scientific part of Lavoisier's work. If he dwells at all on the details of his career as an administrator, it is only for the purpose of explaining the conditions which directed, controlled, or in any way modified the course of his investigations. For the greater part of these details he is mainly indebted to M. Grimaux. M. Berthelot has, however, enjoyed this advantage over M. Grimaux, that he has been in a position to study the minutes of the Academy, more especially at about the period of the Revolution, and he has had the rare privilege of being able to peruse the laboratory journals of Lavoisier, which had been preserved by the pious care of Madame Lavoisier and her descendants. These documents are of the greatest interest and importance, for they enable us not only to determine the exact time and sequence of his researches, but also to trace the gradual development of his conceptions, and the manner in which he shook himself free from the trammels of phlogistonism. These registers, thirteen in number, are deposited in the Archives of the Institute. They have been most carefully examined and collated by M. Berthelot, and a statement of the results of the analysis forms a considerable and specially valuable section of his work.

It is a remarkable circumstance, as M. Grimaux has already stated, that, in spite of the glory which surrounds the name of Lavoisier, a century should have elapsed before any substantial effort should have been made to do justice to his memory. Beyond the *éloge* by Fourcroy (inspired, there is too much reason to fear, by the extraordinary revulsion of public feeling which immediately followed the death of Robespierre), and the short biographical notices by Lalande and Cuvier, there had been no real attempt to deal with the career of the man whom his countrymen regard as the Newton of chemistry until the appearance of M. Grimaux's book. Dumas—who exercised such a predominant influence on chemical thought in France, and who throughout his life professed the most fervent admiration for Lavoisier, the official republication of whose works he superintended—never did more towards the realization of his oft-repeated intention of producing such a monograph as M. Grimaux has now given us than is to be seen in a few enthusiastic pages, more eloquent, perhaps, than exact, in his "Leçons de Philosophie Chimique." The tardiness of this reparation does not fail to strike M. Berthelot, and he ventures to discuss its cause. We do not propose to follow him in this. *Qui s'excuse s'accuse*: the conclusion is not creditable to the national fame or to its sense of retributive justice. No statue of Lavoisier is to be found in the city of his birth and death. Republican Paris is apparently unwilling to give any outward and visible sign of contrition for the great crime of May 8, 1794.

It is hardly surprising that in a book written at a time when France had invited the world to assist her to commemorate an epoch which had such a tremendous influence on her destiny, M. Berthelot should have sought and found a parallel between the work of Lavoisier and the great upheaval which so completely changed the social and political aspect of his country. The active revolt against phlogistonism no doubt had its origin in France, and Lavoisier was unquestionably the leader in the revolution. That, however, is not saying that he was the actual author of it. Black, who in this as in other matters was far ahead of the scientific thought of his age, had already convinced himself of the inadequacy of Stahl's generalization even as a theory of combustion, and Black's influence still counted for something in this country. Indeed, as Lavoisier admits, it also counted for much with at least one man in France, and that man was Lavoisier himself. He spoke of Black as "le savant illustre qui le premier a réuni et mis en corps de doctrine le phénomène de la fixation de l'air dans les corps." Black's great discovery was, in fact, the real beginning of *la révolution chimique*. M. Berthelot is constrained to admit this.

> "La théorie du phlogistique recevait par là une première atteinte : les changements survenus dans les propriétés de la chaux et des alcalis caustiques se trouvant expliqués, non par la présence ou l'absence de cet agent mystérieux, comme on l'avait fait jusque-là ; mais par celle d'une matière chimique déterminée, que l'on pouvait recueillir, peser, et transporter d'une combinaison dans une autre. Aussi les partisans de la théorie régnante se hâtèrent-ils de réfuter Black. Il s'engagea à cette occasion une première lutte, qui préluda à la grande discussion de Lavoisier."

Black, however, was not fitted to lead a revolution. A man of philosophic calm, gentle and somewhat retiring in disposition, he had nothing of the fire and energy of Lavoisier; he hated controversy, and was constitutionally so indolent that it was only under pressure that he could be induced to write out the results of his investigations for publication. Black, who wrote French with ease—he was born at Bordeaux, and spent much of his youth there—frequently corresponded with Lavoisier, and next to his friend Hutton there was probably no one who knew more of his opinions on current scientific topics. We have it on the authority of Thomas Thomson that Black felt hurt at the publication of several of Lavoisier's papers in the *Mémoires de l'Académie*, without any allusion whatever to what he himself had previously done on the same subject. Thomson adds, however, that, "from the posthumous works of Lavoisier, there is some reason for believing that, if he had lived, he would have done justice to all parties; but the re is no doubt that Dr. Black, in the meantime, thought himself aggrieved, and that he formed the intention of doing himself justice by publishing an account of his own discoveries; however, this intention was thwarted and prevented by bad health" ("History of Chemistry," vol. i. 330).

We have ventured to say this much in justice to Black, not because we wish in any way to disparage Lavoisier, or to minimize the greatness of his services to the philosophy of chemistry, but because we think that M. Berthelot has allowed his analogy to run away with him. To say that Lavoisier was the actual author of *la révolution chimique* is hardly more true than the statement that Marat was the author of the Revolution of 1789. The learned author of the "Introduction à la Chimie des Anciens et du Moyen Age" stops short of attempting to prove the truth of Wurtz's saying that "chemistry is a French science; its founder was Lavoisier of immortal memory;" but we cannot help thinking that the circumstances under which his book was produced have in some measure warped his critical faculty; and that, seduced by analogy—that fruitful parent of error—he has been led to claim for his hero a pre-eminence in the creation of the new order of things that the unbiassed historian could not possibly grant.

T. E. THORPE.

THE ORGANISMS INFESTING WATER-WORKS.

Die Pflanzen und Thiere in den dunkeln Räumen der Rotterdamer Wasserleitung. Bericht über die Biologischen Untersuchungen der Crenothrix-Commission zu Rotterdam, vom Jahre 1887. Erstattet von Hugo de Vries. (Jena: Gustav Fischer, 1890.)

THE water-works of Rotterdam obtain their supply of water from the River Meuse, and apparently were able to filter and purify it in a satisfactory manner until the spring of 1887, when the Schizomycete *Crenothrix Kühniana* made its appearance in great abundance in the various reservoirs and aqueducts. This gave rise to so much trouble and difficulty in obtaining a pure water-supply, that new and improved filters were made, and finally a Commission of investigation was appointed, which carried on its work chiefly during the winter 1887–88. Some further questions bearing on the matter were investigated in the following year, and now we have before us the chief scientific results of the Report sent in by the Professor of Botany at Amsterdam, Hugo de Vries, and giving a most interesting account not only of this particular pest, the *Crenothrix*, but also of the other plants and animals found living in the dark places of the Rotterdam aqueducts.

A small laboratory was fitted up in the water-tower of one of the reservoirs, so that Prof. de Vries and Dr. F. Dupont, who conducted the microscopical investigations, might have every opportunity of examining the plants and animals in a living condition. In the first part (50 pages) of the paper the attached organisms found in the aqueducts in 1887 are described, beginning with *Crenothrix Kühniana* (one of the "iron-bacteria"), of which a full account, with figures, is given. This organism was found to be undoubtedly the chief cause of the impurity of the Rotterdam water-supply, as it also had been in the case of the "water-calamity" of Berlin in 1878. Its powers of reproduction are so enormous that in a very short space of time it can spread in abundance over a wide area and render a vast amount of water impure. De Vries comes to the conclusion from his observations that *Crenothrix* does not vegetate in the soil, as had been supposed to be the case by Brefeld and Zopf in the Berlin investigations, but is derived merely from the basins and canals of unfiltered water.

The fixed plants and animals—(1) in the Meuse and in the open basins, (2) in the covered-in canals for the unfiltered water, and (3) in the dark chambers containing the purified water—are successively described, and various interesting observations noted. *Spongilla* (*Meyenia*) *fluviatilis* was found, in the dark passages, covering the walls in a thin layer, and was of a white colour, in place of being green as it is when exposed to the light. The fresh-water mussel, *Dreyssena polymorpha*, and the hydroid zoophyte *Cordylophora lacustris* were found in great abundance in some parts; lower worms, Rotifers, Infusoria, some Crustacea, and a few Molluscs in others; and a luxuriance of fresh-water Polyzoa of the genera *Plumatella* and *Paludicella* in other parts of the system—over 30 species in all being observed, and these very much the same forms which Kraepelin had found in the Hamburg aqueducts, and Potts in those of Philadelphia—while *Crenothrix* was present everywhere, apparently covering everything in great abundance. In the filters, however, and in the channels containing filtered water, only *Crenothrix* and a few other Algæ were found. The Sponges, Zoophytes, Polyzoa, and Molluscs were entirely absent.

The second part of the work deals with the free-swimming animals—the fresh-water Crustacea. Of these, two species, *Asellus aquaticus* and *Gammarus pulex* unlike the attached animals (Polyzoa, &c.), are able to penetrate into the filtered waters along with the *Crenothrix*; and in 1887 these Crustaceans developed in the purified water to such an extent as to be a perfect plague, thus giving an excellent example of the rate of increase of a species unchecked (for a time, at least) by competition. The *Gammari* and *Aselli* which penetrated to the filtered waters had the field to themselves, they had found a niche of nature previously unoccupied by any animals, they had food and other conditions necessary for life, and plenty of room, so they increased with astonishing rapidity.

In regard to their nourishment, the *Gammari* were found by de Vries to subsist upon the *Crenothrix*, which they thus to some small extent helped to keep down; while the *Asellus*, as was proved by an examination of the fæcal pellets and of the alimentary canal, eats the wood-work used in the construction of the filters, and also the hyphæ, conidia, &c., of the Fungus *Melanomma pulvis-pyrius*. The *Aselli* are found to eat away the softer spring wood of the beams, and leave the harder autumn wood of the annual rings standing out as ridges. Consequently one important practical conclusion at which the Rotterdam Commission arrived was that the wooden beams in the filters should be removed, and their place be taken by cement, which would not afford shelter and nourishment to the Crustacea, Fungi, and other organisms. The Report is illustrated by woodcuts, and a plate giving a plan of the Rotterdam water-works, so as to show the connection between the various reservoirs and aqueducts and the course taken by the water in passing through the system.

W. A. HERDMAN.

AMERICAN GEMS.

Gems and Precious Stones of North America: a Popular Description of their Occurrence, Value, History, Archæology, and of the Collections in which they exist; also a Chapter on Pearls, and on Remarkable Foreign Gems owned in the United States. Illustrated with Eight Coloured Plates and numerous minor Engravings. By George Frederick Kunz. (New York: The Scientific Publishing Company, 1890.)

THE general dissociation in Nature of useful and ornamental materials, which has often been commented upon, finds nowhere a more striking illustration than in the North American continent. Rich as this part of the globe is in coal, the ores of iron, and of almost all the metals employed in the arts, as well as in all kinds of building materials, yet the value of gem-stones found within its limits is practically insignificant. As the author of the work before us admits,

> "the daily yield from the iron and coal mines, or from the South African diamond mines, or a week's yield of the granite quarries, would exceed in value the entire output of precious stones found in the United States during a year."

Small though their aggregate value may be, however, there are many facts concerning the variations in character and the mode of occurrence of these interesting and beautiful objects, the gem-stones, which can better be studied in North America than in any other part of the world. Nor could we possibly wish for a more fully informed guide than Mr. Kunz: his skill as a mineralogist is well known, and he has frequently, in his capacity of gem-expert to Messrs. Tiffany and Co., been able not only to reject the spurious but to recognize for the first time the latent capabilities of mineral varieties not previously employed as gems. Since the year 1883, Major J. W. Powell, the Director of the U.S. Geological Survey, has published a valuable series of annual volumes on "The Mineral Resources of the United States"; and the chapters on precious stones in these reports have been written by Mr. Kunz.

The book aims at combining the exact information required by the mineralogist with the curious and sometimes trivial, but by no means unimportant, lore dear to the collector and the archæologist. As is fitting in such a work, the typography and illustrations are of remarkable excellence, and reflect the highest credit upon the printers and engravers of the United States; indeed, it would be hard to find anywhere a volume which combines so many excellences, alike in the paper, printing, plates, and binding.

Every care has evidently been given to making the scientific part of the work trustworthy; and we may especially refer to the chapters which deal with the corundums, the beryls, and the felspars of the United States, as containing much new and valuable information. The details concerning the silicified ("jasperized") woods of Arizona given in this book are more complete and satisfactory than any that have before appeared, while the accounts of the pearls and pearl-fisheries of North America are full of interest. In order to make the work more complete, the twelve chapters on the gems of the United States are followed by two others on the precious stones of Canada and Mexico respectively. Little more than an enumeration of the gem-stones of the Dominion can be given in the space at the command of the author, but more justice is done to the jades, opals, and obsidians of Mexico.

The two last chapters deal respectively with the lapidaries' work performed by the aborigines of North America, and the work of the same kind now being done in the country; and both chapters abound with curious and interesting facts. The publication of this book cannot fail to call attention to the importance of systematic searches being carried on with a view to the discovery of some of the more valuable gem-stones, in districts where no authentic account of their occurrence at present exists. Collectors, archæologists, jewellers, and dealers will all find their respective wants anticipated by Mr. Kunz; and by attention to the methods of discrimination and the detection of fraud which he indicates, will be saved frequent disappointment and much pecuniary loss.

J. W. J.

OUR BOOK SHELF.

Timbers, and how to Know Them. By Dr. R. Hartig, Professor of Botany in Munich University. Translated by W. Somerville. (Edinburgh: Douglas, 1890.)

THE original of this little book is the third edition of a small pamphlet entitled "Die Anatomischen Unterscheidungsmerkmale der wichtigeren in Deutschland wachsender Hölzer," and why the translator should have altered the significance of the title is not explained. In any case it would not be easy to justify the more ambitious title of the English translation, seeing that no additions have been made to the original, and that the original title claims too much. For the book does little more than give in bare outline the more conspicuous features observed on the transverse sections of our common woods; and although this is done fairly well, the treatment is neither exhaustive nor free from defects.

The only other alterations made by the translator are the additions of an index and a glossary. The former appears adequate and useful, the latter has shortcomings, especially under the headings "bordered pit," "parenchymatous cells," &c. Definitions such as "*Vertical resin-duct*, one which runs longitudinally, *i.e.* parallel to the outside of a stem," are, to say the least, not improved by the additional remark.

With regard to the actual translation, it is good and accurate on the whole: so faithful is it that Mr. Somerville has omitted to correct Hartig's own mistake as to the generic name of the teak, which reappears in the English edition as *Tectonia*—surely the translator knows it should be *Tectona!*

The chief defects in the original pamphlet may be summed up in that characters are relied on for distinguishing closely allied woods which do not serve the purpose. For instance, the broad medullary rays, so called, of the alder are a very treacherous guide; and the admission that the wood of *Æsculus* "occupies a position midway between" the hard and soft woods, itself shows how useless the property of hardness is, as a class character, unless defined in a rigid manner.

Both the selection and the description of the seven exotic timbers mentioned in the appendix are faulty, and we are driven to the conclusion that there is room for a much better book on the subject than the little pioneer under review. As a pioneer, however, it is to be welcomed, with its useful, compact information, as well as its failings.

Advanced Physiography (*Physiographic Astronomy*). By John Mills. (London: Chapman and Hall, 1890.)

THE introductory part of this book is a reprint of the elementary lessons in the subject by the same author (NATURE, vol. xlii. p. 76), and the remainder is intended to meet the requirements of advanced students in connection with the Science and Art examinations. The new material constitutes a fair general outline of the subject, but some of the descriptions suffer from want of detail. There are also indications of the author's unfamiliarity with some parts of the subject. On p. 248, for example, it is evident that the author is not well acquainted with stellar nomenclature, as he does not seem to be aware that Roman capitals are reserved for recently discovered variable stars. Again, on p. 253, he gives some figures relating to variable stars, which he evidently does not understand; he forgets to point out that Dunér's observations of stars were all of one spectroscopic group, and that the numbers given show that the maximum of variability occurs in that particular group. It should be an author's duty to use no term which he has not explained, but on page 114 he refers to the moon's mean horizontal parallax, although the meaning is not even hinted at.

The excellent plan of writing a head-line over each important paragraph has been adopted, but has not been employed consistently throughout. Thus, under the heading "To weigh a planet having a satellite," we find also a reference to the determination of the masses of the moon and the satellites of Jupiter and Saturn; and again, the chapter headed "Celestial Photography" consists largely of terrestrial magnetism.

The illustrations are numerous, but of varying quality; it is difficult to imagine what kind of telescope would give such a view of the moon as that represented in Fig. 93.

Travels in Africa. By Dr. Wilhelm Junker. Translated from the German by A. H. Keane, F.R.G.S. (London: Chapman and Hall, 1890.)

THE work of which this is a translation records Dr. Junker's experiences as a geographical explorer from the year 1875 to 1878. Besides an excursion to the Siwa Oasis and Natron Valley, it includes "a careful survey of the Báraka watercourse, wanderings through Upper Nubia, an expedition to the Sobat River, and numerous journeys throughout Makaraka Land and surrounding regions." It is to his later work that Dr. Junker chiefly owes his fame as an explorer; but in the present volume he gives an account of many notable achievements, and, as the translator points out, his descriptions of Makaraka Land and neighbouring districts will supply cartographers with plentiful material for filling up their blank spaces in an extensive region. Dr. Junker is a good writer as well as a bold and scientific traveller, and no one who begins to read his narrative will find it hard to go on to the end. The translator has done his work carefully, and the interest of the story is much increased by a valuable map and many good illustrations.

Selected Subjects in connection with the Surgery of Infancy and Childhood. By Edmund Owen, M.B., F.R.C.S. (London: Baillière, Tindall, and Cox, 1890.)

IN this volume Dr. Owen has published (by request) the Lettsomian Lectures delivered by him at the Medical Society of London in the present year. The position of Lettsomian Lecturer has been held by so many illustrious members of the profession that he seems to have undertaken with diffidence the task entrusted to him. The subjects with which he decided to deal have of late, as he says, been attracting considerable attention; and no one can doubt that they are of great practical importance. Dr. Owen discourses on them not only with learning, but with the directness, clearness, and force that spring from careful and long-continued observation.

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.*]

The Correspondence on Russian Transliteration.

As absence from England prevented our replying at the time to the last letters on the system of Russian transliteration proposed in NATURE (vol. xli. p. 397), we thought it best to delay reply till any further communications from foreign correspondents had arrived. Since our last note (NATURE, vol. xli. p. 535) four letters have been received:—

(1) Mr. Wilkins (NATURE, May 22, p. 77) writes from Tashkend to point out that the system fails to distinguish between the few Russian words which differ only in their final semi-vowel. This is quite correct, but could only be avoided by the adoption of a separate symbol for each of these two characters and their retention at the ends of words. The addition to the trouble of printing that this would involve would be far more serious than the chance of error: *krob*, a roof, is hardly more likely to be confused with *krob*, blood, than, in a quite analogous case, is the German *band*, a volume, with *band*, a ribbon.

We do not accept Mr. Wilkins's criticism that *ui* does not "even remotely" represent the sound of ы. In the use of the letter in such a word as Полный we fully admit that this is so; but in other cases, as after a labial, it seems to us to represent the sound fairly well. Phonetically, Prībuilov (to take Mr. Wilkins's own case) is not so exact as Prĭbū°lŏff, as the word would probably be rendered by the elaborate refinements of the "Historical English Dictionary"; but even this is inadequate. We despair of any correct phonetic rendering of Russian words in English characters till a system is arranged on the lines of Dr. Murray's; and then the word would appear in some such guise as [illegible]. *Ui* seems to us on the average, and certainly in the case chosen by Mr. Wilkins, a better phonetic equivalent than *y*—a letter which is unfairly overworked in nearly all systems of transliterations, and which we have reserved exclusively for the double symbols *ya*, *ye*, *yu*.

(2) Mr. Wilkins, and our second critic, Baron Osten-Sacken (NATURE, May 22, p. 77), agree in condemning the adoption of *zh* for ж. A strong case can no doubt be made out for the claim of *j* to represent that letter, and *zh* was accepted (largely on phonetic grounds) as one of those mutual concessions which Baron Osten-Sacken commends. *Zh* has been largely used—almost universally in America—and it represents the sound better than the English *j*. No doubt the French *j* of *jour* is as near to it as the *zh* sound in the word *az(h)ure*. As the system proposed was intended for English-speaking countries we thought it inadvisable to adopt a French sound for one letter. The system is not so ambitious as Baron Osten-Sacken suggests it

should be. The methods of transliteration used in Germany and France differ so much from one another, and both from the English, that it seemed hardly possible, however desirable, to get one system adopted for the three languages.

In regard to Baron Osten-Sacken's other points, we regard *tch* and *stch* as inadvisable for ч and ш respectively, as, without the use of brackets, they would be mistaken for other sequences; and it was generally agreed that brackets should only be used as a very last resource. Finally, *æ* for the rare and practically extinct Ѵ is as good a phonetic equivalent as anything else, and more convenient than the already overburdened *y*.

(3) We cordially agree with the main point in Mr. Chisholm's argument (NATURE, May 1, p. 6), viz. that different systems are required for different purposes. The phonetic method adopted by the Geographical Society is unquestionably the best suited for their maps, but is quite inadequate for bibliographic use. We are glad to see that the system proposed for the latter purpose has Mr. Chisholm's approval.

(4) Mr. Groves (NATURE, May 1, p. 6) quotes a case that strikes him as very cumbrous; but we fail to see that the alteration to SKRJIPSKY is a sufficient improvement to be worth the inconveniences that the changes would involve in other cases. Under no system could a page of transliterated Russian hope to read like Addisonian English.

We do not see that, in the cases we quoted in our reply to Mr. Groves's former letter, we really misunderstood him. We do not know whence or how the three Gazetteers derived their renderings of Nizhniĭ; we only quoted them to show how many different spellings were current, and that the word, as transliterated by the new system, is neither unintelligible nor materially different from forms already in use. In the cases to which we attached most weight, viz. the titles of journals quoted from Scudder, Bolton, and the *Geological Record* the transliterations were certainly derived direct from the Russian, and we thought it probable that the Chemical Society's Journal would also have quoted the papers from the original rather than from second-hand German sources.

In conclusion, it is advisable again to repeat that the system was proposed solely for bibliographic use in the English language: the bibliographers who laid down the requirements of the system insisted that it should be based on two principles and should satisfy four rules. Had these been published in the original note, some subsequent criticisms would probably not have been made. Considering that the criticisms that really apply to this non-phonetic, unæsthetic system do not require any changes to be made in it, we hope that it will be adopted by other journals and catalogues. A supplementary list of those that do so will be published in the fuller account and explanation of the system that will be issued shortly.

H. A. MIERS.
J. W. GREGORY.

Discovery of a New Comet.

WHILE sweeping the northern sky at 11h. 35m. on the night of July 23, with a 10-inch reflector, power 40, I found a nebulous object near θ and ζ Ursæ Minoris, which I could not identify. It was faint, round, about 1′ in diameter, and with a very slight central condensation. I noted its position relatively to the stars near, but clouds then came over and prevented further observations for nearly an hour. On reobserving the object I found it to be a comet, a considerable displacement having occurred in its position.

On July 24 I obtained another view of it, and found its diurnal motion to be about 55′ to the south. At 11h. the comet was close to a star of about the ninth magnitude. At 11h. 40m. the comet was centrally projected upon the star, and the latter appeared to be involved in an extensive atmosphere. At about 12h. 30m. the comet reappeared on the other side of the star. I could not resist the impression that the star was decidedly fainter when the comet was passing over it.

The rough estimated positions of the comet were:—

	h.		°	°
July 23,	12 ...	...	228	+ 78
,, 24,	12 ...	...	228	+ 77

On July 25 and 26 the sky was cloudy and the comet not seen. It will be invisible during moonlight, but on about August 5 or 6 it ought to be picked up before moonrise in the region between γ Ursæ Minoris and ι Draconis, or at about 226° + 66°.

It is probable that this comet is approaching its perihelion and becoming brighter, in which case it may be readily seen when the sky is clear and free from moonlight.

Bristol, July 27. W. F. DENNING.

P.S.—The comet was observed at Nice on July 25, 10h., when its R.A. was 15h. 14m. (228½°), Decl. 76° 37′ N.

The Rotation of Mercury.

IN the February number of *Himmel und Erde*, and elsewhere, I have seen "that the otherwise meritorious, but in his observations and their discussion not always cautious and strict Schroeter," took the rotation period of Mercury to be twenty-four hours, but that Schiaparelli has now found that Mercury behaves to the sun as the moon to the earth, always showing the same side. The reporter also explained, by way of compliment to Prof. G. Darwin, why the planet next to the sun should differ in this respect from its companions.

As all astronomers like fair play, I went through Schroeter's papers, and read Schiaparelli's letter, No. 2944, *Astronomische Nachrichten*, which shows the usual industry, lucidity of style, and good faith of the Professor.

Schroeter and his companion Harding found the southern hemisphere of the planet rounded (*rundlich*) like the northern, but believed that they saw every twenty-four hours a certain change of form of the southern end of the lighted crescent, not perceptible in the northern. This was the leading observation, of which Schiaparelli remarks: "Of all facts known with regard to Mercury's rotation, this reappearance about every twenty-four hours of a truncation of the southern horn is the most manifest and anciently known" ("un apparente troncatura del corno australe è il più manifesto e anticamente cognosciuto").

Schroeter and Harding had for some time tried in vain to trace on the face of the planet some spot confirming their conclusion, when one day Harding first and Schroeter afterwards perceived a dark streak appearing in the east and moving west over the face of the planet. Both observed the phenomenon, with varying distinctness and under different combinations, during many days, and held that it confirmed their original hypothesis. Schroeter found that considerable increase of the magnifying power of his instrument lessened the distinctness of the shading.

Schiaparelli commenced his investigation because he considered Schroeter's result doubtful, and had instruments far superior to those used ninety years ago.

He has observed Mercury since 1881 more than 500 times, and has made on the most favourable days about 150 drawings, "to say the truth of very unequal value, but nevertheless so far agreeing as to furnish a result." That is, drawings on which the admittedly indistinct and varying feeble shadings united into one dissolving view did not always appear to be the same. The author also tells us that he made "one of his best observations when the planet was only at 3° 2′ from the limb of the sun," and "the disk of the planet then appeared perfectly round and uniformly bright;" and finally confesses, "Of these forms and streaks I have endeavoured to give an idea on the annexed drawing without concealing from myself the futility of such an attempt."

The Professor first made use of his "eight-inch instrument," then of "the eighteen," which showed the shading less distinctly, so as to make him write, "I have the impression that if one looked with a still stronger instrument all would appear dissolved in still more minute formations."

He lastly formulates three hypotheses: (1) the period is 24 hours; (2) the period divides the 24 hours without remainders; (3) there is no rotation properly speaking. He adopts No. 3, and concludes that the different appearances are caused by the great libration consequent upon the large eccentricity of its orbit.

Should there be no farther hypotheses possible, when the results of research are so conflicting, indistinct, and variable?

R.

Birds and Flowers.

IN reference to Mr. Wallace's letter (p. 295) with regard to a note in NATURE (July 17, p. 279), I correctly quoted Mr. Scott-Elliot's remark, who says:—

"I am led to entirely disagree with Mr. Wallace's opinion that the colour of flower-seeking birds is quite unconnected with their habits. As a matter of fact a peculiar shade of red found on the breast of *Cinnyris chalybea*, *C. afra*, *C. famosa*, *C. sonimanga*, and *C. bicollaris* is exactly the same as that which I found in the majority of ornithophilous flowers in South Africa. It is, moreover, not a common colour in flowers; and since Labiatæ, Aloes, Irids, and Leguminosæ all assume it when they become ornithophilous, some reason must be shown why the simple explanation given by Darwin should be set aside while no other is offered."

THE WRITER OF THE NOTE.

CHELSEA BOTANIC GARDEN.

THE physic garden at Chelsea covers an area of between three and four acres. It stands by the side of the Thames at the east end of Cheyne Walk, opposite Battersea Park, a short distance west of Chelsea Hospital. On three sides it is inclosed by a high brick wall, and on the fourth you look through iron railings on to the Thames Embankment and the river. Within this area there are a dwelling-house, rooms for the gardeners, a large lecture-room, and four conservatories, and the rest is laid out in walks, flower-beds, and grassy interspaces. It is now too much surrounded by houses for trees to prosper, but one of the cedars of Lebanon planted in 1683 still survives. Amongst the others may be seen, or were until lately, well-grown examples of Oriental plane, Salisburia, Wistaria, hawthorn, black walnut, black mulberry, and many others. One of the most striking features of the garden is a large bed of yuccas on the north. It contains one of the finest collections of the different species and hybrids of rhubarb to be found anywhere in the country. The most valuable portion of its contents is a collection of between 300 and 400 hardy plants and shrubs, which are or have been used in medicine. These are arranged, shrubs and herbaceous plants intermixed, according to the system of Jussieu and De Candolle. There is a smaller collection arranged after the system of Lindley, who for many years directed the garden and gave the lectures. From these are sent up the plants which are required for the examinations which are held in the old hall of the Company near Blackfriars Bridge. Against the wall that flanks the garden on the east are nailed the fig and other tender shrubs, and beneath there is a narrow border containing Ferula, Verbascum, Acanthus, the fibre-yielding Chinese and Indian *Boehmeria nivea*, and a crowd of other herbaceous plants. In the centre of the garden there is a statue of Sir Hans Sloane, and a tank full of buckbean and water violet, surrounded by rockwork on which grow saxifrages, Hieracia, and spiny Astragali. South of the main walk that cuts the garden into two halves are beds full of non-medicinal plants, arranged in natural orders, another tank full of water lilies, bur-reeds, and bulrushes, and south of all have lately been laid out a couple of beds containing types of the twenty natural orders a knowledge of which is required for the elementary examination of the Science and Art Department. The present rainy season has suited the garden capitally, and during many years' acquaintance with it the writer of this article has never seen the herbaceous plants look more luxuriant than they do at the present time.

It would take up more space than we can spare to say even a few words about each of the distinguished botanists who have been connected with the garden. Here was laid the foundation of the classical "Gardener's Dictionary" of Philip Miller, which was first published in 1731, ran through eight editions in his life-time, has been translated into German, French, and Dutch, and formed the foundation and model of the many gardeners' dictionaries that have since been written. Amongst the well-known botanists of older date who were more or less connected with the garden, were Doody, Petiver, Hudson, Rand, and Alchorne, and in later times Lindley, Fortune, Thomas Moore, Curtis, Anderson, and David Don. Full particulars about all these will be found in Field's history of the garden, published in 1820, and a second edition, considerably enlarged, published by Dr. Semple in 1878.

The ground was originally taken by the Apothecaries' Company in 1673, as a spot on which to build a convenient house for their ornamental barge. In 1674 a wall was built round the open space, and the cultivation of medicinal plants commenced. At first the ground was rented, at a nominal sum, from Lord Cheyne, who was then lord of the manor of Chelsea. In 1712 the property was purchased by Dr. (afterwards Sir Hans) Sloane. In 1722, Sir Hans Sloane granted the use of the ground in perpetuity to the Apothecaries' Company at a yearly rent of £5, to the end, says the deed, "that the said garden may at all times hereafter be continued as a physic garden, and for the better encouraging and enabling the said Society to support the charge thereof, for the manifestation of the power, wisdom, and glory of God in the works of the creation, and that their apprentices and others may better distinguish good and useful plants from those that bear resemblance to them that are hurtful." If these conditions are not fulfilled by the Apothecaries, the garden reverts to the Royal Society on the same terms, and if they fail to fulfil them it falls to the College of Physicians. Under this deed the Society of Apothecaries has now held the garden for 170 years, during which time, of course, the land has greatly increased in value.

At the present time the garden is used for botanical purposes by four classes of students:—

Firstly, those who are going up for the preliminary examination of the Apothecaries' Company, in which materia medica is one of the principal subjects. This examination, we understand, is often taken by those who seek places as chemists and druggists, and who do not intend to proceed to the L.S.A. Secondly, the ladies who compete for the silver medal which has lately been offered annually by the Apothecaries' Company. Thirdly, pharmaceutical students. One of the largest private pharmaceutical schools is situated in the neighbourhood. Fourthly, students who are intending to go up for the botanical examinations of the Science and Art Department. For this there have been about 3000 entries per annum for many years, and 25 per cent. of the marks (30 per cent. being a second class pass) are allotted for a description of a plant and a diagnosis of its natural order. Probably we should be justified in estimating that a quarter of these 3000 candidates live in London, and cannot get living specimens to study without undertaking a railway journey, and of course it is only fair to assume that those who have passed their examination will continue to take an interest in the science, particularly as many of them teach botany in elementary schools. It is only the first and second of these four classes of students who have any direct claim on the Apothecaries' Company, but they have always construed liberally the "others" mentioned in Sir Hans Sloane's deed. Last year the number of admissions by students' tickets, as registered in the visitors' book, was 3000. A course of twelve lectures and demonstrations have been given for many years in summer by Mr. J. G. Baker, and at these the annual attendance ranges from 550 to 700, or an average of 50 or 60 students to each lecture.

The Society of Apothecaries have given no public intimation that they are dissatisfied with the present condition of things, but they bear the whole expense of keeping up the garden, and reap only a share of the benefit. A Committee has been appointed by the Royal Society to consider their position in the matter; and last week a meeting was held in the Town Hall at Chelsea, at which Lord Meath presided and Prof. Flower was one of the speakers, at which the following resolution was passed: "That this meeting of the inhabitants of Chelsea, having heard that there is a probability of the old physic garden on the Chelsea Embankment being no longer kept up by the Apothecaries' Company, considers that every effort should be made to preserve it for the public as an open space." Under these circumstances we wish to put in a plea that the claims of the London students of systematic botany and materia medica should not be overlooked, or the scantiness of their opportunities for the study of living plants forgotten.

THE SEARCH FOR COAL IN THE SOUTH OF ENGLAND.[1]

(1) THE bare facts of the recent discovery of coal-measures at Shakespeare Cliff, near Dover, have been published in the press, and the full account cannot be written till the completion of the inquiry which is now going on. It is, however, not unfitting that the bearing of the discovery on the general question of the existence of workable coal-fields in Southern England should be discussed within these walls, not merely on account of its general interest, but because it naturally follows the paper read by Mr. Godwin-Austen before the Royal Institution, in 1858, "On the Probability of Coal beneath the South-Eastern parts of England." In 1855 he had placed before the Geological Society of London the possibility of the existence of coal in South-Eastern England at a workable depth. In the two years which had elapsed, "the possibility" had grown in his mind into the "probability," and in the thirty-two years which have passed between the date of the paper before this Institution and the present time, "the probability" has been converted into a certainty by the recent discovery at Dover. In this communication, the lines of the inquiry laid down by Godwin-Austen will be strictly followed. We must first examine the conditions under which the coal-measures were accumulated.

(2) The seams of coal are proved, by the surface-soil traversed by roots and rootlets, to which in some cases the trunks are still attached, to have been formed *in situ* by the growth and decay of innumerable generations of plants (*Lepidodendra*, *Sigillaria*, *Calamites*), pines (*Trigonocarpa*, *Dadoxylon*, *Sternbergia*) allied to *Salisburia*, and a vast undergrowth of ferns, all of which contributed to form a peat-like morass. Each seam represents an accumulation on a land-surface, just as the sandstones and shales above it point to a period of depression during which sand-banks and mud-banks were deposited by water. The fact also that the coal-seams in a given sinking are parallel, or nearly parallel, implies that they were formed on horizontal tracts of alluvium, while the marine and fresh-water shells in the associated sandstones and shales prove that they were near the level of the sea, or within reach of a mighty river. This tract of forest-clad marsh-lands, as Godwin-Austen and Prestwich have pointed out, occupied the greater part of the British Isles, from the Highlands of Scotland southwards as far as Brittany, and eastwards far away into the valley of the Rhine, and westwards over the greater part of Ireland. It swept round the hills of South Scotland and the Lake district and the region of Cornwall. It occupied a delta like that of the Mississippi, in which the forest-growths were from time to time depressed beneath the water-line, until the whole thickness of the coal-measures (7200 feet thick in Lancashire, 7600 in South Wales, and 8400 in Somersetshire) was built up. After each depression the forest spread again over the sand and mud of the submerged parts, and another peat-layer of vegetable matter was slowly accumulated above that buried beneath the sand and mud. The great extent of this delta implies the existence of a large river draining a large continent, of which the Highlands of Scotland and the Scandinavian peninsula formed parts, and which I have described before the Royal Institution under the name of Archaia.

(3) At the close of the Carboniferous age, this vast tract of alluvium was thrown into a series of folds by earth-movements. These have left their mark in the south of England and the adjacent parts of France, in the anticline of the English Channel, the syncline of Devonshire, the anticline of the Mendip Hills and of the lower Severn, and the syncline of the South Wales coal-fields. These great east and west folds have been traced from the south of Ireland on the west, through 35 degrees of latitude, through North France and Belgium, as far as the region of Westphalia. Next, the upper portions of the folds were attacked by the subaërial and marine agents of denudation over the whole of the Carboniferous area, leaving the lower parts to form the existing coal-fields which lie scattered over the surface of the British Isles, and are isolated from each other by exposures of older rocks; and a broad east and west ridge was carved out of the folded and broken Carboniferous and older rocks, extending from the anticline of the Mendip Hills eastward through Artois into Germany, and constituting the ridge or axis of Artois of Godwin-Austen.

The next stage in the history of the folded Carboniferous and older rocks is marked by the deposition of the Permian and Secondary rocks on their eroded and water-worn edges, by which they were partially concealed or wholly buried, and these newer strata thin off as they approach the ridge of Artois. This barrier, also, of folded Carboniferous and older rocks sank gradually beneath the sea in the Triassic, Liassic, Oolitic, and Cretaceous ages, and against it the strata of the first three named ages thin off, while in France and Belgium the Cretaceous deposits rest immediately upon the water-worn older rocks.

From these general considerations it is clear that the coal-measures which formerly extended over nearly the whole of Southern England can now only be met with in isolated basins under the newer rocks, and that these are thinnest along the line of the above-mentioned barrier.

(4) The exposed coal-fields in Britain, and on the Continent also, Godwin-Austen pointed out, along this line, are of the same mineral character, and the pre-Carboniferous rocks are the same. This ridge or barrier also, where it is concealed by the newer rocks, is marked by the arch-like fold (anticlinal) of the chalk of Wiltshire, and by the line of the North Downs in Surrey and Kent. Godwin-Austen finally concluded that there are coal-fields beneath the Oolitic and Cretaceous rocks in the south of England, and that they are near enough to the surface along the line of the ridge to be capable of being worked. He mentioned the Thames Valley and the Weald of Kent and Sussex as possible places where they might be discovered.

These strikingly original views gradually made their way, and in the next eleven years became part of the general body of geological theory. They were, however, not accepted by Sir Roderick Murchison, the then head of the Geological Survey, who maintained to the last that there were no valuable coal-fields in Southern England.

(5) The next important step in the direction of their verification was that taken by the Coal Commission of 1866-67, by whom Mr. Godwin-Austen was examined at length, and the results of the inquiry embodied in the Report by Mr. Prestwich. In the Report Mr. Godwin-Austen's views are accepted, and fortified by a vast number of details relating both to the coal-fields of Somersetshire and of France and Belgium. Mr. Prestwich also calls special attention to the physical identity of the coals of these two regions, and to the fact that the Carboniferous and older rocks in both are similarly dis-

[1] Friday Evening Lecture delivered at the Royal Institution on June 6, by Prof. W. Boyd Dawkins, F.R.S.

turbed. He concludes, further, that the coal-fields which now lie buried beneath the newer rocks are probably equal in value and in extent to those which are exposed in Somerset and South Wales on the west, and in Belgium and France on the east.

We will now proceed to test these theoretical conclusions by the light of recent observations.

(6) The coal-fields of Somerset and Gloucester were proved by the labours of Prof. Prestwich and the Coal Commission of 1866–67 to be small fractions of the great coal-basin which lies buried beneath the Triassic, Liassic, and Oolitic rocks, from the Mendip Hills northwards past Bristol to Wickwar. On the west also three small isolated coal-basins occur—those of Nailsea and Portishead, which are partially, and that of Aust, which is wholly, concealed by the newer rocks. The coal-measures are folded and broken, and traversed by great "overthrust" faults, which at Kingswood give the same series of coals twice over in the sinkings of one colliery. Their southern boundary is the line of the Mendip Hills. They also probably occur at a depth which remains to be proved, still further to the south, in the valley of the Axe and the district of Glastonbury, the most southern boundary being the mountain limestone of Cannington, near Bridgwater. The great Somerset and Gloucester field may extend to the east under the newer rocks, between Freshford and Beckington, in the district south of Bath.

The value of the evidence of the coal-fields of the west of England on the general question consists in the fact that they may be taken as fair samples of those which lie concealed along the line of the buried ridge through South-Eastern England in the direction of France, Belgium, and Germany.

(7) One of these concealed coal-fields has been struck in a deep boring at Burford, near Witney, in Oxfordshire, at a depth of 1184 feet, under the following rocks :—

	Feet.
Oolites	148
Lias	598
Rhætic	10
Triassic rocks	428

The sandstones and shales of the coal-measures were penetrated to a depth of 225 feet (De Rance, Manch. Geol. Soc., March 26, 1878).

These coal-measure rocks form, as suggested by Hull, one of the same series of coal-basins as those of South Wales and the Forest of Dean, and probably mark the line of the continuation of the South Wales syncline in the direction of Harwich, where Carboniferous shale has been struck at a depth of 1052 feet from the surface.

This boring proves not merely the presence of coal-measures at a workable depth in Oxfordshire, but also the important fact that the Triassic rocks, which are of great thickness further north, have dwindled down to an unimportant thickness in their range southwards and eastwards. Further, that south, in the London area, these rocks are wholly absent; and farther to the east, at Harwich, the Liassic and Oolitic strata and Lower Greensand are absent, and the Gault rests on the eroded Lower Carboniferous rocks, inclined at a high angle.

(8) The water-worn surface of the folded rocks, which are older than the Carboniferous, has been repeatedly struck in deep borlngs for water in the neighbourhood of London, at depths ranging from 839 feet at Ware to 1239 feet at Richmond. They consist of Silurian strata in the north at Ware, and of Old Red Sandstone or Devonian rocks in the other localities. From their high angle of dip, as in the case of similar rocks underlying the coal-fields of Somerset and Northern France and Belgium, it may be inferred that coal-fields lie in the synclinal folds in the neighbouring areas.

From the fact of the Silurian rocks being in the north, while all the rest of the borings to the south terminate in the Devonian or Old Red rocks, it may be inferred that the chalk of the North Downs probably conceals the coal-measures. It must also be noted that there are no Wealden rocks in the London area, and no Lower Greensands, and that the Lower Oolites at their thickest are only 87 feet. The secondary rocks, which are of great thickness in the midland and northern counties, thin off as they pass southwards towards London, against the ridge of older rocks, as both Austen and Prestwich have pointed out.

It is therefore in the area south of London, rather than in that immediately to the north, that the coal-measures are to be looked for at a workable depth beneath the surface, and underneath the chalk of the North Downs. It must, however, be noted that the line of the South Wales syncline through Burford passes to the north of Ware, and that there may be coal-measures in the northern parts of Essex and of Hertfordshire at a workable depth.

(9) The Report of the Coal Commission was published in 1871, and in the following year the Sub-Wealden Exploration Committee was organized by Mr. Henry Willett, to test the question of the existence of the Carboniferous and pre-Carboniferous rocks in the Wealden area by an experimental boring. The site chosen was Netherfield, about 3 miles south of Battle, in Sussex, where the lowest rocks of the Wealden formation constitute the bottom of the valley. The rocks penetrated were as follows :—

Section of Netherfield.

	Feet.
Purbeck strata...	200
Portland strata	57
Kimmeridge clay	1073
Corallian strata	515
Oxford clay	60
	1905

This boring showed that the coal-measures and older rocks are, in that region, more than 1900 feet from the surface of the ground. We may also infer, from the fact of the bottom of the bore-hole being in the Oxford clay, and from the known thickness of the Bath Oolitic strata in the nearest places, that it lies buried beneath considerably more than 2000 feet of newer rocks. With this valuable, though negative result, the Sub-Wealden exploration came to an end. It was a purely scientific inquiry, paid for by subscription, and largely supported by those who had no pecuniary interest in the result.

The experience of the boring at Netherfield showed that the search for the coal-measures and older rocks of Godwin-Austen's ridge would have to be carried out at some spot further to the north, in the direction of the North Downs. In the district of Battle the Oolitic rocks were proved to be more than 1700 feet thick, and the great and increasing thickness of the successive rocks of the Wealden formation above them, which form the surface of the ground between Netherfield and the North Downs, rendered it undesirable to repeat the experiment within the Wealden area proper, where the Wealden rocks presented a total thickness of more than 1000 feet, in addition to that of the Oolites. My attention, therefore, was directed to the line along the North Downs, where Godwin-Austen believed that the Wealden beds abruptly terminated against the ridge of coal-measures and older rocks, and where, therefore, there would be a greater chance of success.

(10) The evidence, also, of the French, Belgian, and Westphalian coal-fields pointed in the direction of the North Downs.

The Carboniferous and older rocks, which we have hitherto traced only as far as the area of London from their western outcrops in Somerset, Gloucestershire, and South Wales, reappear at the surface in Northern France, Belgium, and Westphalia, and contain most valuable coal-fields, which are long, narrow, and deep. These extend from the district of the Ruhr on the east, through Aachen, Liége, Namur, Charleroi, Mons, and Valenciennes. The enormous value of the last field led, during the last hundred years, to numerous borings through the newer rocks, which have extended the western range of the coal-measures upwards of 95 miles away from its disappearance under the Oolites and chalk, as far as Flechinelle, south of Aire, or to within 30 miles of Calais. It occupies throughout this distance a narrow trough or syncline, 11 miles across at Douchy, and about half a mile at its western termination. It is represented still further to the west by the faulted and folded coal-fields of Hardinghen and Marquise, which are within about 12 miles of Calais. The coal-measure shales and sandstones found in a boring at Calais, at a depth of 1104 feet from the surface, in 1850,[1] reveal the existence of another coal-field in the same general line of strike, and making for Dover and the North Downs.

(11) We have seen that the range of the coal-measures has been pushed farther and farther to the west by experimental borings, until they have been proved to exist underneath Calais. The opposite shores of the Straits of Dover, therefore, presented the best locality for a trial still further to the west. In choosing a site, the Channel Tunnel works, close to Shakespeare Cliff, Dover, appeared to me to present great advantages, which I embodied in a report to Sir Edward W. Watkin, in 1886. The site is within view of Calais, and not more than 6 miles to the south of a spot where about 4 cwt. of bituminous material was found embedded in the chalk in making a tunnel, which, according to Godwin-Austen, had been probably derived from the coal-measures below.

Prestwich also had pointed out, in 1873, in dealing with the question of a tunnel between England and France, that the older rocks were within such easy reach at Dover, that they could be utilized for the making of a submarine tunnel. Sir Edward Watkin acted with his usual energy, and the work was begun in 1886, and has been carried on down to the present time, under my advice, and at the expense of the Channel Tunnel Company. The boring operations have been under the direction of Mr. F. Brady, the Chief Engineer of the South-Eastern Railway, to whose ability we owe the completion of the work to its present point, under circumstances of great difficulty. A

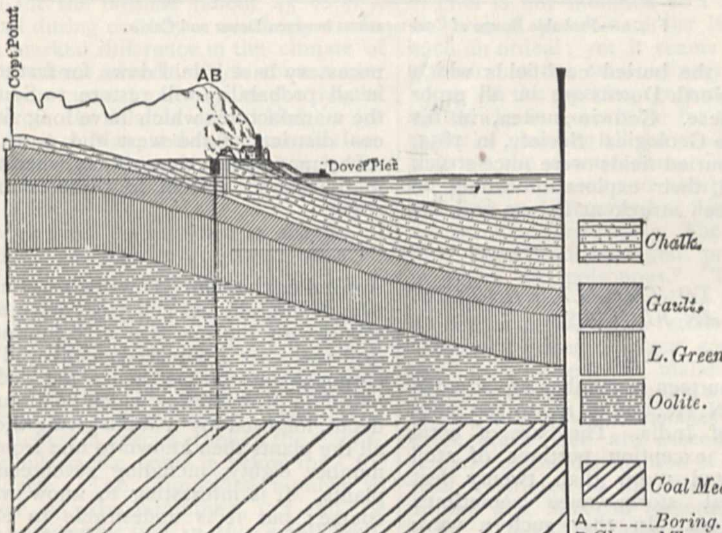


Fig. 1.—Boring at Shakespeare Cliff.

shaft has been sunk (A, Fig. 1) on the west side of the Shakespeare Cliff, close to the shaft of the Channel Tunnel (B) to a depth of 44 feet, and from this a bore-hole has been made to a depth of 1180 feet.

Section at Shakespeare Cliff, Dover.

	Feet.
Lower grey chalk, and chalk marl	
Glauconite marl	500
Gault	
Neocomian	
Portlandian	
Kimmeridgian	
Corallian	660
Oxfordian...	
Callovian	
Bathonian	
Coal-measures, sandstones, and shale sand clays, with one seam of coal	70

The coal-measures were struck at a depth of 1204 feet from the surface, or 1160 feet from the top of the bore-hole, and a seam of good blazing coal was met with [illegible]2 feet lower.

(12) This discovery proves up to the hilt the truth o Godwin-Austen's views as to the range of the coal-measures along the line of the North Downs, and as to the thinning off of the Oolitic and Wealden strata against the buried ridge. The former are less than one-third of their thickness at Netherfield, and the latter are wholly unrepresented. It establishes the existence of a coal-field in South-Eastern England, at a depth well within the limits of working at a profit. The principal coal-pits in this country are worked at depths ranging from over 1000 to 2800 feet, and one at Charleroi, in Belgium, is worked to a depth of 3412 feet.

The Dover coal-field probably forms part of the same narrow trough as the Calais measures, prolonged westward under the Channel further to the south than Godwin-Austen drew it in 1858. Whether it is a trough similar to that which extends through Northern France for more than 100 miles from east to west, as Godwin-Austen has drawn it in the diagram on the wall, reaching as far to the west as Reading, or whether it is a small, faulted, insignificant fragment of a field, such as that of Marquise and Hardinghen, remains to be proved. It is,

[1] This fact is doubted by Gosselet. I am, however, informed by Prestwich that both he and Elie de Beaumont identified them as coal-measures at the time, and I see no reason for doubting the accuracy of those two eminent observers. The cores were, unfortunately, lost in the first Paris Exhibition.

however, one of a chain of coal-fields which will, in my opinion, ultimately be proved to extend under the newer rocks between Dover and Somerset, along the line of the North Downs, in long narrow east and west troughs. It is probably a continuation beneath the Straits of Dover of the coal-measures struck at Calais (see Fig. 2).

The further question as to the value of these fields may be answered by the amount of coal in the fields which are now being worked in Westphalia, Belgium, France, and Somersetshire. The Westphalian coal-field contains 294 feet of workable coal, distributed in 117 seams; that of Mons, 250 feet, in 110 seams; and that of Somerset, 98 feet, in 55 seams. The North French coal-field in 1887 yielded 7,119,633 tons, and gave employment at the pits to 29,000 men, and is rapidly increasing its output.

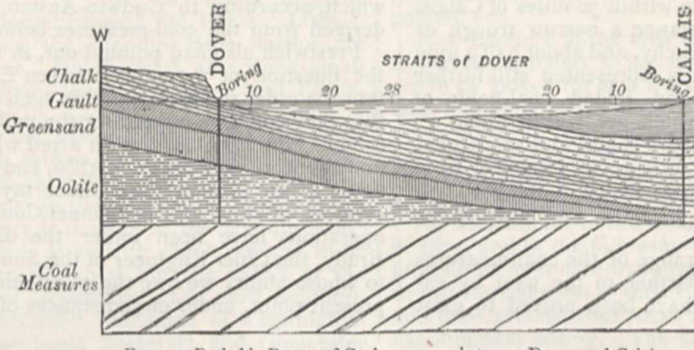


FIG. 2.—Probable Range of Coal-measures between Dover and Calais.

It may be inferred that the buried coal-fields which await the explorer in the North Downs are in all probability not inferior to these. Godwin-Austen, in his memorable paper before the Geological Society, in 1855, said that if one of these buried fields were once struck in South-Eastern England, their exploration would be an easy matter. It has been struck at Dover, and the necessary base is laid down for further discoveries, which in all probability will restore to South-Eastern England the manufactures which have long since fled away to the coal districts of the west and north, and which will put off by many years the evil day when the energy stored up in the shape of coal in these islands shall have been spent.

RECENT ADDITIONS TO THE LITERATURE OF INSULAR FLORAS.

THE LACCADIVES.

THESE small islands, fourteen in number, are situated between 10° and 14° N. lat., and at 120 to 180 miles from the Malabar coast of India. They are of coral formation, almost without exception portions of atoll rings, and nowhere elevated more than twenty feet above the sea, so that storm-waves sometimes sweep completely over them. In 1847 such a wave destroyed 1000 of the small population, and there have been equally disastrous cyclones in much more recent times. Indeed, according to Hunter's Imperial Gazetteer of India, the islands, which have an area of two to three square miles, are nowhere more than ten or fifteen feet above the level of the sea. In 1871 the population was estimated at about 13,500, and the almost sole cultivation is the coco-nut palm. It is supposed that the abundance of this palm may have attracted the first settlers, but as that event occurred more than 350 years ago—how much more it is impossible to say—this point must remain uncertain. The total annual value of the exports, consisting almost entirely of the products of the coco-nut palm, is said to be about £17,000. From the physical character of the group, it was not expected that the flora contained any endemic element, but until quite recently there was no published account of the vegetation, beyond broad generalizations. Dr. D. Prain, Curator of the Calcutta Herbarium, has supplied the want in the "Memoirs by Medical Officers of the Army of India," Part V., where he gives an enumeration and analysis of all the plants hitherto known by him to have been collected in the islands, and he has since communicated to the writer a list of some twenty additional species. Briefly, the vegetation consists, apart from cultivation, of very widely dispersed plants—whose wide area is due to ocean currents, birds, or winds—plus a number of weeds of tropical cultivation. Dr. Prain has not visited any of the islands himself, and collectors have not concerned themselves with the question of colonization of plants from drift-seeds or from seeds conveyed to the islands by carpophagous birds; hence his deductions are mainly based on probabilities, which he discusses in considerable detail, followed by a table giving the full distribution of all the plants then known to him from the islands. These number eighty, including seventeen purely cultivated plants. It is interesting to know what is cultivated, of course; but it is undesirable to encumber the distributional tables with plants of this category. Dr. Prain estimates that the presence of eleven species is certainly due to the sea, seventeen probably so, and twenty-two possibly so; whilst birds are regarded as the agents in two, three, and five instances respectively. The two ferns collected in the island of Anderut are set down with certainty to the wind, and two or three other plants probably to the same agency. The rarity of ferns seems to be accounted for, in part at least, by the extreme flatness of the islands rather than by unfavourable conditions, for Dr. Treub found eleven species of ferns on the elevated part of Krakataõ only three years after the great eruption, which absolutely destroyed all the vegetation previously existing, and covered the island with a volcanic deposit of intense heat from one to sixty yards in thickness.

One common tree in the vegetation of many islands of the Indian Ocean we miss in Dr. Prain's list, and that is *Cordia subcordata*, the iron-wood of the Keeling Islands.

THE KURILES.

Mr. Kingo Miyabe, lately appointed Professor of Botany at the Agricultural College, Sapporo, Japan, and formerly a student at Harvard, U.S., and for a short time in this country, is the author of a "Flora of the Kurile Islands," which is published in the Memoirs of the Boston [U.S.] Society of Natural History, vol. iv., No. 7.

This is perhaps the most finished piece of systematic and geographical botany yet published in English by a Japanese botanist, and it will give the author a reputation for completeness and conciseness that might be envied by many western botanists. The enumeration is based partly on personal observation and partly on scattered records and herbarium specimens, for which full references are given; and all authorities are cited, so that the sources of information are not uncertain, as is too often the case.

The Kurile Islands form a chain nearly 800 miles long, extending from the southern point of Kamtschatka to Yezo; and, by treaty with Russia in 1875, they are now all under Japanese rule. The principal islands are about twenty-four in number, but they are only partly inhabited, on account of their barrenness and lack of good water. The whole chain is described as of volcanic origin, and fifty-two cones have been observed, seventeen of which were active. The coasts generally are precipitous and unapproachable, and the few bays and coves they possess are insufficiently sheltered to be safe for ships in bad weather. Indeed, some of the islands can only be visited in the perfectly calm weather of the summer-time. In consequence of the sea-currents from the north, the climate is very cold for the latitude (about 43° to 51°), and dense fogs prevail during easterly or southerly winds. There is, however, a marked difference in the climate of two or three of the southern islands, which come under the influence of a warm current running to the north-east. North of Etorofu the islands are locked in ice from November till April or May, and the mountains are snow-capped throughout the summer; hence it is not surprising to learn that the vegetation is of a sub-arctic character.

Mr. Miyabe's enumeration comprises 299 species of flowering plants, and 18 vascular cryptogams; but it is not supposed that these numbers exhaust the flora. These 317 species belong to 187 genera and 53 natural orders, and 21 of the latter are represented by a single genus, and 9 by a single species each. The natural orders comparatively rich in genera are: Compositæ, 15; Rosaceæ and Liliaceæ, 12; Gramineæ, 11; Ranunculaceæ and Ericaceæ, 8; Cruciferæ and Umbelliferæ, 7; and most of these orders are the richest in species, though the Caryophyllaceæ and Scrophulariaceæ come in before the Cruciferæ and Umbelliferæ. The Compositæ number 30 species; the Rosaceæ, 23; the Gramineæ, 17; and the Ericaceæ, 16. It is noteworthy that in this small flora, or, rather, portion of a flora, the Compositæ form a relatively high percentage, as they do in the Arctic flora and in the various regions of Central and Eastern Asia, from the Caspian to Japan, whose floras have been analyzed by Maximowicz. So far as at present known, the Kurile flora contains no endemic element, unless we except two imperfectly-known plants, which, however, as Mr. Miyabe observes, are much more likely to be forms of more widely-spread species. North of the islands mentioned as under the influence of a warm sea-current, the flora is largely composed of species having a wider range, many of them all round the northern hemisphere, and species having a more or less wide area in North-East Asia. The facts that upwards of 25 per cent. of the species are British, and that 84 per cent. of the genera are spread over Europe, Northern Asia, and North America, will assist us in forming an idea of the general composition of the vegetation. Only three of the genera are restricted to the mountains of tropical Asia and North-Eastern Asia—namely, *Skimmia*, *Crawfurdia*, and *Acanthopanax*. Mr. Miyabe finds that 26 per cent. of the species are American-Asiatic; and 10 per cent. of these reach Eastern North America. Only six genera occur which do not reach Japan—namely, *Parrya*, *Tetrapoma*, *Claytonia*, *Lupinus*, *Armeria*, and *Dodecatheon*.

The existence in the southern islands, Kunashiri and Etorofu, of such plants as the following is strong evidence of a warmer climate: *Dianthus superbus*, *Hypericum erectum*, *Skimmia japonica*, *Ilex crenata*, *Rhus Toxicodendron*, *Hydrangea scandens*, *Aralia racemosa*, *Acanthopanax ricinifolia*, *Crawfurdia japonica*, and *Bambusa Kurilensis*. The bamboo is said to grow so thick and so tall in the neighbourhood of Shana, in Etorofu, as to form almost impassable thickets.

Mr. Miyabe concludes his discussion of the flora of the Kuriles in the following words:—"From these observations I agree with Prof. Milne in the opinion that, at the time of the last great southerly migration of the rich polar flora, Japan received her portion mostly through the island of Saghalin, and but little, if any, through the then uncompleted chain of the Kurile Islands."

The Bahamas.

A provisional list of the plants of this chain of islands, by John Gardiner and L. J. K. Brace, edited by Prof. C. Dolley, appears in the Proceedings of the Academy of Natural Sciences, Philadelphia, 1889, pp. 131–426.

This is not intended as a critical review, and perhaps an avowed provisional list is, in a sense, exempt from such an ordeal; yet it seems no more than right to call attention to the extraordinary notes and remarks under some of the species, genera, and orders, so that the writer who is responsible for them may have the opportunity of claiming all the credit due to him. Taking the first of the dicotyledons, *Clematis Vitalba*, it is said to be "indigenous and nearly cosmopolitan"; and *Delphinium* sp. is recorded as "indigenous from old world," whatever that may mean. The Bixineæ, "as a whole, have fully bitter and astringent properties, and some of the members are poisonous." This is indefinite, but the Compositæ are described as "plants mostly possessing a bitter principle which renders them tonic"; and *Eupatorium* (a genus of about 500 species) "is extensively used as a remedy for malaria." A more definite statement, "grasses are valuable as food for cattle and men," is true, although the instances on record of men having eaten grass itself are exceedingly rare. Some of the remarks on the distribution of the plants enumerated, and really restricted to the West Indian region, or the West Indian and Mexican regions, are equally incomprehensible. Thus *Alvaradoa amorphoides*, a shrub inhabiting the Bahamas, Cuba, and Mexico, including the interior province of Chihuahua in the north, is said to be found on "all tropical coasts." The work abounds in indefinite, and often unintelligible, remarks on the medicinal properties of plants. Under *Clethra tinifolia* we find the note: "This plant does not appear to be of use for anything. The order [Ericaceæ] has astringent properties. Its leaves and flowers are used as a diaphoretic; they are saponaceous and detergent."

The list itself is largely compiled from Grisebach's "Flora of the British West Indies," and from names communicated from Kew to Mr. Brace, based on specimens supplied by him from time to time; and is so far approximately correct. On the other hand, some of the additional names are strangely inaccurate and far-fetched Thus, *Sinapis Brassicata*, Linn., a Chinese plant, now believed to be the same as *S. juncea*, is put down as mustard, and as native of the West Indies. It is true that Grisebach uses this name in his "Flora of the British West Indian Islands," therefore it is, to that extent, excusable. That an "M.D." and a Professor of Biology should be so careless of his reputation as to publish such undigested matter is inconceivable. Apart from its faults, the list is imperfect so far as our present knowledge goes, and it may be better to await an emended edition before attempting to give any particulars of the flora here.

FERNANDO NORONHA.

Darwin landed on this island on the outward voyage of the *Beagle*, and collected a few plants, and Moseley succeeded in obtaining specimens of a few plants from the main island and the islet of St. Michael's Mount, but was prevented from making a complete collection in consequence of the *Challenger* being unprovided with the necessary authorization. These plants were described by the writer, and some of them figured in the "Botany of the *Challenger* Expedition." Provided with funds by the Royal Society, Mr. H. N. Ridley, formerly of the British Museum, and now Government Botanist for the Straits Settlements, visited the island in the summer of 1887, accompanied by Mr. G. A. Ramage and the Rev. T. S. Lea. The party remained on the island, or rather group, for there are several islets besides the main island, forming a chain, which may have formerly been continuous. Thus they had time to explore thoroughly the natural history; and an account of the botany, by Ridley, has just appeared in the current volume of the Journal of the Linnean Society. The singularly unconnected form of the introductory matter is doubtless due to the hurried manner in which it had to be completed before the author's departure for Singapore.

Fernando Noronha is in about 3° 50′ S. lat., and nearly 200 miles from the nearest point of the Brazilian coast. The whole chain is about eight miles in length, and the main island five miles long and nearly two miles across in one part, though very much narrower generally.

The fragment of the flora published in the "Botany of the *Challenger*" was considered sufficient to enable us to form an opinion of its general character, and state that there was no peculiarly insular element in the vegetation. This is fully borne out by the subsequent discoveries.

Mr. Ridley gives no analysis of the composition of the flora beyond classifying the plants as weeds, such plants as might be introduced by sea-currents, and such as have berries and eatable seeds, with examples; but he does not tabulate the whole. His very brief "summary" follows:—

"The whole group of islands possesses certain characteristics common to all truly oceanic islands and some of those which are merely the relics of vanished continents. In the first place there is the absence of indigenous mammals, and more noticeably of bats, of fresh-water fish, and amphibians. Again, the number of indigenous species, both of plants and animals, is very small, while the number of individuals is very large. The insects are small and dull in colour, and but few of the plants have showy flowers, white and yellow being prevailing colours. A considerable proportion of the indigenous plants are shrubby or arboreous, as in many other oceanic islands; but arboreous or even shrubby Compositæ do not exist, indigenous species of the order being rare in the group."

There will be differences of opinion, of course, as to the teachings of the data collected by Mr. Ridley and his companions, especially as to whether the present vegetation be a remnant of a former continental flora or a purely derived insular flora of comparatively recent origin.

Mr. Ridley himself states "that there is no evidence whatever to show a former connection with the mainland of Brazil at any time, in spite of what has been asserted by Dr. Rattray to the contrary." On the other hand, in a sketch of the geology of the island, based on petrological notes by Thomas Davies, which follows the enumeration, it is merely doubted "that the evidence is sufficient to prove a connection."

It appears, too, that "some American petrologists, who have found similar rocks to those of Fernando Noronha in the neighbourhood of Cape San Roque, seem to consider that the group may have been connected at one time with the mainland at this point."

Roughly counting the plants in the enumeration, we find there are nearly two hundred species of phanerogams, including weeds and a few others undoubtedly introduced, intentionally or unintentionally, by man. Out of this total, about thirty-two are described as new, or, in about half-a-dozen instances, more fully described than was possible from the imperfect material previously known. So far as present evidence goes, these are all endemic in Fernando Noronha; but while so much remains to be done in the investigation of the Brazilian flora, it should not be assumed that they are really so. Some of them, indeed, are admittedly very closely allied to previously-described species, and botanists might differ as to the propriety or expediency of treating the majority of them as independent species. And as to the whole, they present no peculiar characteristic suggesting the improbability of their occurring on the mainland.

The poverty of the flora in species may be largely due to climatal and other conditions. The climate is so dry generally, or the periods of drought are so protracted, that marsh plants, epiphytes, and ferns are almost wholly wanting. Mr. Ridley discovered one fern, *Pellæa geraniæfolia*, but it was rare and local, and this very widely-spread fern will grow in comparatively dry situations.

A large number of the plants, including several of the supposed endemic species, bear edible fruits; yet "there is only one fruit-eating bird on the island, and that is the endemic dove, *Zenaida noronhæ*." This fact tempts Mr. Ridley "to wonder whether the number of endemic species with edible fruit could possibly have all been introduced by this single species of dove, or whether other frugivorous birds may not at times have wandered to the shores." This sentence can hardly convey what Mr. Ridley had in his mind when he wrote; and being so distant from home he probably had no opportunity of revising it in print. Moreover, it is hardly correct to designate this group of islands as "oceanic."

Prominent in the vegetation among the assumed new or endemic plants are: *Erythrina aurantiaca*, *Cereus insularis*, *Bignonia roseo-alba*, *Pisonia Darwinii*, *Sapium sceleratum*, and *Ficus noronhæ*. There are also described two species of *Oxalis*, three of *Ceratosanthes*, a genus of Cucurbitaceæ, a *Sesuvium*, a *Cuscuta*, a *Physalis*, a *Solanum*, a *Lantana*, and three of *Cyperus*, besides a few others of less familiar genera. Of greater botanical interest is an apparently diœcious Combretacea, provisionally placed in *Combretum* as the type of a new section, *Terminaliopsis*. Taken as a whole, the vegetation is quite that of the mainland deprived of the moisture-loving element.

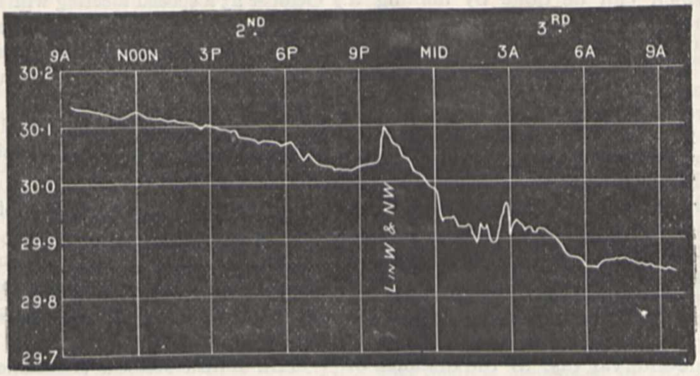
In conclusion, it may be stated that the woods mentioned by the earlier writers have almost disappeared since the main island has been made a convict settlement.

W. BOTTING HEMSLEY.

THE BRONTOMETER.

FOR more than a century meteorologists have been puzzled by the exceptional action of the barometer during some (not all) thunderstorms, and during some (but not all) heavy rains. As a general rule, one expects the barometer to fall for rain and bad weather, but in 1784 Rosenthal pointed out that "when a thunderstorm approaches the place where a barometer is situated, the mercury in the tube begins to rise; the nearer the thundercloud comes to the zenith of the observer, the higher does the mercury rise, and reaches its highest point when the storm is at the least distance from the observer. As soon, however, as the cloud has passed the zenith, or has become more distant from the observer, the weight of the atmosphere begins to decrease and the mercury to fall."

The recent rapid increase in the number of self-recording barometers in use has led to much interest being taken in these fluctuations, which are sometimes very numerous, and far from the simple rise and fall noted by Rosenthal, Planer, Toaldo, and other early writers. A very good illustration was afforded by my Redier barograph on August 2-3, 1879, of which the curve is reproduced below.



Camden Square, London, August 1879.

It might for a moment be supposed that the zig-zag about 2 a.m. was due to what is known as "pumping" in the barometer, but that is not the case. "Pumping" rarely takes a minute from its lowest to its highest point, *i.e.* two minutes from one maximum to another,[1] whereas these maxima are at intervals of about half an hour.

Several explanations of these oscillations have been offered, and in my paper in the Proc. Roy. Soc. I have endeavoured to give a summary of them, but I have long felt that as a preliminary to a theory we ought to be sure of the facts.

Years ago, when Sir Francis Ronalds, F.R.S., had his collection of electrometers in the dome of Kew Observatory, he devised what he called a storm clock, which was really a paper going at a regular rate, so that the observer needed only to record the phenomena, and the position of his writing showed the time.

In 1890 we ought to do better than half a century ago, and, thanks to the great skill of MM. Richard Frères, of Paris, the new machine, if it does not absolutely justify its name "brontometer" (Βροντὴ μέτρον, thunderstorm measurer), is a very near approach to it.

And first as to the object, we want to find out (1) the nature of the oscillations already mentioned; and (2) to what they are due.

The only way to do this is to get them on so large a scale that they can be critically examined, and to find out with what phenomena they are synchronous, or in definite relation as to sequence and time. Irrespective altogether of these barometric oscillations there are several features in thunderstorms not at all understood, such, for instance, as whether the rush of rain which sometimes accompanies an exceptionally fine flash of lightning is the cause or the result of that flash. For this and other points absolutely accurate time is of the highest importance, and evidently all phenomena must be recorded on one sheet of paper.

A method adopted for some of his instruments by Mr. H. C. Russell, F.R.S., of Sydney, might with advantage be copied in some of the European Observatories. As a general rule, and for ordinary phenomena, half an inch of paper for an hour of time, *i.e.* 12 inches per diem, gives a sufficiently open scale; but when special phenomena occur it is very handy to be able to accelerate the speed five or ten times, and this Mr. Russell does with ease. But even ten times times the ordinary speed, or 5 inches an hour, would not enable one to read closer than to quarter minutes, which would be useless for ascertaining the details of a thunderstorm and the correlation of the various phenomena with the peculiar oscillations already mentioned.

These, then, are some of the reasons which led me, more than three years since, to consult MM. Richard as to the construction of the brontometer, now at length completed.

It is provided with endless paper, 12 inches wide, travelling under the various recording pens at the rate of 1·2 inch per minute, or 6 feet per hour. This is about 150 times faster than is usual in meteorological instruments, and enables the time of any phenomenon to be read off with certainty to a single second of time.

The traces are made in aniline ink by a series of seven Richard pens.

The first pen is driven by the clock which feeds the paper, so that the time scale and the paper must go together. The pen usually produces a straight line, which serves as the base line for all measurements, but at 55 seconds after each minute the pen begins to go, at an angle of about 45°, one-tenth of an inch to the left, and at the sixtieth second it flies back to its original position.

The second pen is driven by one of Richard's anemocinemographs—a name which they have given to a pattern of anemometer not yet known in England. The external portion has some resemblance to the ordinary windmill governor, but it differs from it in that the plates are curved, not flat; they are made of aluminium, and are so light that they have little momentum, and have thus a great advantage over cups, which run on for many seconds after the wind-force has decreased or ceased. The fans make one revolution for each metre of wind that passes, and send an electric current to the brontometer, where it acts on an electro-magnet, and tends to draw this (second) pen towards the left; but a train of clock-work is constantly tending to draw the pen to the right, the joint result being that the pen continuously shows, not the total motion (as is the case with most anemometers), but the actual velocity almost second by second. It does this certainly with an error of less than five seconds, for the fans will stop dead in less than that time, and the clock-work train will bring the pen from indicating a velocity of 70 miles an hour to 20 miles an hour in three seconds, and down to a dead calm in seven seconds. The trace will thus resemble that of a pressure anemometer, but with a much more open scale than was ever before available.

The third pen is actuated by a handle, and can be set at zero or at 1, 2, 3, or 4 spaces from it. The author's

[1] I believe that half a minute would be nearer, but until the brontometer has been worked during a heavy gale no one knows.

original idea was, partly by watching a storm-rain-gauge, and partly by estimation, to decide on the intensity of the rain, and to indicate that intensity by moving the pen further and further from zero as the fall becomes heavier. Experience alone will show whether that is, or is not, superior to moving it one step for each $\frac{1}{100}$th of an inch of fallen rain, which can be done by making a Crosley rain-gauge send a current into the room where the brontometer is placed, and strike a bell there. In a heavy storm there will, however, be so much for the observer to do, that very probably count would be lost. It may, therefore, be necessary to make it act automatically.

The fourth pen is actuated somewhat like a piano. On the occurrence of a flash of lightning, the observer presses a key, the pen travels slightly to the right, and flies back to zero. Referred to the automatic time-scale, this gives, to a second, the time at which the key was depressed.

The fifth pen is similar, but, being intended to record the thunder, the observer will continue to hold down the key until the roll is inaudible. The time of the departure of this pen from zero will evidently be later than that for the lightning by the time-interval due to the distance of the flash, and possibly something may be learned from the accurate record of the duration of the thunder.

The sixth pen is similar to the third, and is intended to record the time, duration, and intensity of hail.

The seventh and last pen is devoted to an automatic record of atmospheric pressure. As the rapid motion of the paper, which is indispensable for studying the details of a thunderstorm, has enlarged the time-scale more than a hundredfold, it was imperative that the barometric scale should itself be greatly enlarged. But the range of the barometer in London is more than 2½ inches, and no enlargement less than ten times the natural (mercurial) scale would be of any use; hence a breadth of 25 inches of paper would be necessary, unless some mode of shifting the indication could be devised.

Several plans were tried, but finally a modification of Richard's statoscope has been adopted, which is so sensitive that it will indicate the opening or shutting of a door in any part of the house, gives a scale of 30 inches for each mercurial inch (*i.e.* about three times that of a glycerine barometer), and yet only requires 4 inches breadth of the brontometer paper. Without entering into all the details of construction, it is desirable to explain the general principle, and its application. As it was essential that the apparatus should record accurately to 0·001 inch of mercurial barometric pressure, it was evident that friction had to be reduced to a minimum, and considerable motive power provided. This is done by placing in the base of the brontometer a galvanized iron chamber, which contains about 3½ cubic feet of air; on the upper part are a series of elastic chambers, similar to the vacuum boxes of aneroid barometers, but much larger. When the instrument is to be put in action, these chambers are connected with the large air-chamber, and a tap is closed which shuts off communication with the external air. Any subsequent increase, or decrease, of atmospheric pressure will compress, or allow to dilate, the air in these chambers, and the motion of the elastic ones produces that of the recording pen.

Obviously, any large change in the temperature of the confined air would vitiate the readings; but (1) the instrument is not required to give absolute, but merely differential, values, and (2) the influence of the changes of temperature is greatly reduced by the chamber being surrounded with 4 inches thick of non-conducting material, besides nearly 1 inch of wood outside of it. The change of temperature in a room, and during the short time that the statoscope will be worked without resetting to zero (*i.e.* without opening the tap) has not hitherto produced any measurable effect.

G. J. SYMONS.

NOTES.

THE Société de Physique et d'Histoire naturelle de Genève has decided to celebrate its hundredth anniversary. It was founded in 1790, having originated in informal meetings of eminent men of science who lived at that time in Geneva. On October 23 a special meeting will be held, at which papers will be read relating to the history of the Society and to the labours of its members. It is hoped also that some honorary members may be disposed to contribute to the success of the meeting by sending scientific communications. In the evening there will be a banquet. Members who intend to be present are asked to write to M. de la Rive, the President, some days before the celebration.

THE International Exhibition of Mining and Metallurgy, at the Crystal Palace, was officially opened on Monday by Lord Thurlow, F.R.S., one of the honorary vice-presidents of the Exhibition. We shall give some account of the Exhibition when the arrangement of the specimens is in a more forward state.

THE British Medical Association is holding its fifty-eighth annual meeting at Birmingham. The President, Dr. Willoughby F. Wade, delivered the opening address on Tuesday. On Wednesday Sir Walter Foster delivered an address in medicine; to-day Mr. Lawson Tait delivers an address in surgery; and to-morrow, at the concluding general meeting, Dr. W. H. Broadbent will speak on therapeutics. At the meeting to-day the Association's gold medal "for distinguished service" will be presented to Surgeon Parke, of the Emin Relief Expedition.

THE summer meeting of the Institution of Mechanical Engineers is being held at Sheffield. It began on Tuesday, July 29, and will not be concluded until to-morrow. The following is a list of the papers: on steel rails, considered chemically and mechanically, by Mr. Christer P. Sandberg, of London; on recent improvements in the mechanical engineering of coal-mines, by Mr. Emerson Bainbridge, of Sheffield; description of the Parkgate iron and steel works, by Mr. Charles J. Stoddart, managing director; description of the Sheffield water works, by Mr. Edward M. Eaton, engineer; description of the Loomis process of making gas for fuel, by Mr. R. N. Oakman, Jun., of London; on milling cutters, by Mr. George Addy, of Sheffield; on some different forms of gas furnaces, by Mr. Bernard Dawson, of Malvern; on the Elihu Thomson electric welding process, by Mr. W. C. Fish, of London (communicated through Prof. Alexander B. W. Kennedy, F.R.S., Vice-President).

THE Leeds Executive Committee, appointed for the purpose of making arrangements for the visit of the British Association, met on Monday. The Mayor, Alderman Elmsley, in opening the proceedings, said that some of the most eminent men of science in Europe and America had announced their intention of being present. Many of the principal manufacturers of Leeds had most generously consented to open their works for inspection by members of the Association. Arrangements had also been made for excursions to places of interest, historical or otherwise. He had no doubt that the inhabitants of Leeds would show all the hospitality and enthusiasm that was required. In the course of the proceedings it was stated that it was the original intention to have a guarantee fund of not less than £500, but that fund now amounted to not less than £6540. A report of the Executive Committee recommended that a call of 50 per cent. should be made on the guarantors, but Mr. Benson Jowitt, in moving the adoption of the report, expressed his belief that eventually it would turn out that the call had been more than sufficient to meet the demands which had been made upon it. The Vicar of Leeds, Dr. Talbot, having seconded the adoption of the report, it was carried, and the proceedings terminated.

THE National Association for the Promotion of Technical and Secondary Education has issued its third annual report. It speaks of the past year as the most eventful one of its existence, so far as the actual realization of the objects of the Association are concerned. The report will be of great interest to anyone who may wish to obtain a general view of the progress which is being made towards the establishment of a proper national system of technical and secondary education.

ATTEMPTS have been made in Parliament this week to secure that the money to be raised from the new tax on spirits shall be applied in Scotland to the establishment of a perfectly free system of elementary education. The Government declines to accept the proposal, which has, therefore, for the present been rejected. On Tuesday evening Mr. Goschen said the matter had been spoken of as a small one, but he thought the decision whether or not the standards above the compulsory standards as well as the compulsory standards themselves should be freed was by no means a very small question. The argument had been put forward that the Government would be justified in freeing parents from the duty (which hon. members now entirely discarded) of educating or contributing to the education of their children. They had relieved parents from that duty where the State had enacted compulsion, but the Government were not prepared to sanction the principle that beyond the compulsory standards education must necessarily be free. Mr. Mundella strongly supported the scheme. He pointed out that the compulsory standard varied in different districts from the third to the sixth. The compulsory standard had been fixed as a minimum, but the Chancellor of the Exchequer would tend to stereotype it, and in many places make it the maximum. Children were passing out of school at an earlier age year by year. In other countries the standard was not one of class, but of age. In Scotland children were passing the fifth standard as early as 10 or 11 years old. The payment of fees had been a great hindrance to the attendance of children at schools. That was why they were dealing with the question now. No doubt the child's wages were a great temptation, but the fee might just make the difference to a poor parent in deciding whether to keep his child at school or not. The present system was a great hardship on precocious children who passed the fifth standard at an early age.

THE Board of Agriculture announce that they have received information reporting the presence of the Hessian fly in the counties of Lincoln, Suffolk, and Herts slightly, and badly near Errol, in Perthshire. Owing to the twisted condition of much of the corn, it is more than usually difficult to detect the presence of the insect. Information is being prepared, and will at once be circulated by the Board.

THE returns presented to the Middlesex County Council by the various inspectors under the muzzling order show that during the quarter ending June last five dogs were seized with rabies in the county, as against seven in the previous quarter. But for the number of cases of rabies the Board of Agriculture would have been asked to withdraw the order. During the same period 526 dogs were seized, 87 of which were claimed and the remainder slaughtered. These figures compare with 1039, 108, and 946 respectively for the March quarter. The total number of dogs seized in the year was 3250, of which 488 were claimed and 2634 slaughtered. In the same period there were 49 cases of rabies, as against 22 in the previous year.

THE trustees of the South African Museum, in their Report for the year ended December 31, 1889, say that in the course of this period valuable assistance was rendered in the palæontological section by Prof. H. G. Seeley, F.R.S., who, during his brief visit to the colony, examined the South African fossils in the Museum, and determined and labelled a considerable number of them. The trustees were glad to learn that Prof. Seeley discovered in the Museum series an apparently new genus, and they had much pleasure in intrusting to his care some of the most interesting specimens for further investigation in England.

WE learn from the *Bulletin* of the Torrey Botanical Club that, through the cordial co-operation of the officers of the New York State Fish Commission, and the great personal interest of its President, Mr. Eugene Blackford, the Brooklyn Institute has been enabled to open a sea-side laboratory for teaching and research in zoology and botany, under the direction of Dr. Bashford Dean. The laboratory is located at Cold Spring Harbour, Long Island, 32 miles from New York, reached by the Long Island Railway. The session opened on July 7, and was to extend over eight weeks; the fee is 24 dollars. The location is described as a capital one, and an extensive corps of lecturers on special subjects has been secured, those on the botanical side being Dr. W. G. Farlow, Dr. N. L. Britton, and Prof. Byron D. Halsted.

THE death is announced of Dr. Alexander von Bunge, the veteran Professor of Botany at the University of Dorpat, at the age of 87. Dr. von Bunge was engaged, in the year 1830, in a scientific expedition in China, and subsequently in Khorassan and Afghanistan. His speciality of recent years was the flora of Russia and of Northern Asia. He was a foreign member of the Linnean Society of London.

SHOCKS of earthquake have lately been felt in different parts of Austria-Hungary. On July 23 two violent though short shocks took place in the Muehl district, in Upper Austria, and on July 25 a violent shock occurred in the valley of the Tscherna, in Moravia. A telegram received at Budapest from Mehadja on July 25 announced that two violent shocks of earthquake had been felt at the Hercules Baths, near that place, at half-past 11 on the previous night. The direction of the disturbance was from east to west.

THE Paris Museum of Natural History received recently from M. J. Bretonnière an interesting sample of limestone (from the suburbs of the town of Constantine in Algeria) in which there are a number of excavations, due apparently to *Helicidæ*. M. Stanislas Meunier thinks that land-snails are enabled to penetrate the rock through the agency of the siliceous particles which were shown by Hancock in 1848 to be the instruments used for similar work by some marine mollusks.

IN his recent thesis on the influence of the sea-shore on leaves M. Pierre Lesage shows by conclusive evidence that a marine, habitat leads to a thickening of the leaves. The palissade-cells are more numerous and larger than in the leaves of the same plants grown inland. Apparently the sea-salt is the cause of this alteration, as plants cultivated in artificially salted soil yield thicker leaves. The observations of M. Lesage bear on some ninety species of plants which are in their natural state found near the sea (in Brittany) as well as inland.

AN excellent paper on the Peabody Museum of American Archæology and Ethnology in Cambridge, U.S., by Frederick W. Putnam, has been reprinted from the Proceedings of the American Antiquarian Society, October 23, 1889. Mr. Putnam, dealing with the problems suggested by the collections of the Museum, thinks that the following are the elements to be taken into consideration in any endeavour to trace the present North American tribes and nations back to their origin. First, small oval-headed Palæolithic man. Second, the long-headed Eskimo. Third, the long-headed people south of the Eskimo. Fourth, the short-headed race of the south-west. Fifth, the Carib element of the south-east. All these elements, Mr. Putnam holds, must be studied with their differences in physical characteristics, in arts, and in languages. "From a commingling of all," he says, "with greater or less predominance of one over the other, uniting here and subdividing there, through many thousand years, there has finally resulted an American people having many characteristics in common, notwithstanding their great diversity in physical characteristics, in arts, in customs, and in languages. To this heterogeneous people the name Indian was given, in misconception, nearly four hundred years ago, and now stands as a stumbling-block in the way of anthropological research; for under the name resemblances are looked for and found, while differences of as great importance in the investigation are counted as mere variations from the type."

THE Royal Society of Victoria has issued the second part of the first volume of its Transactions. Baron von Mueller begins this collection of papers with important "records of observations on Sir William Macgregor's highland plants from New Guinea." Mr. Arthur Dendy writes on the anatomy of an Australian land planarian; Prof. W. Baldwin Spencer on the anatomy of *Amphiptyches urna* (Grube and Wagner). A paper on the preparation of alkyl-sulphine, selenine, and phosphonium salts is by Prof. Orme Masson. Mr. A. W. Howitt, in a well-arranged and instructive paper, deals with the organization of Australian tribes. The following are among Mr. Howitt's conclusions:—(1) The group is the sole unit. The individual is subordinate in the more primitive form of society, but becomes more and more predominant in the advancing social stages. Thus group marriage becomes at length completely subordinate to individual marriage, or even practically extinct and forgotten where descent has been changed from the female to the male line. (2) An Australian tribe is not a number of individuals associated together by reason of relationship and propinquity merely. It is an organized society governed by strict customary laws, which are administered by the elder men, who in very many, if not in all, tribes exercise their inherited authority after secret consultation. (3) There are probably in all tribes men who are recognized as the headmen of class divisions, totems, or of local divisions, and to whom more or less of obedience is freely given. There are more than traces of the inheritance by sons (own or tribal) of the authority of these headmen, and there is thus more than a mere foreshadowing of a chieftainship of the tribe in a hereditary form. (4) Relationship is of group to group, and the individual takes the relationship of his group, and shares with it the collective and individual rights and liabilities. The general result arrived at is that the Australian savages have a social organization which has been developed from a state when two groups of people were living together with almost all things in common, and when within the group there was a regulated sexual promiscuity. The existence of two exogamous intermarrying groups seems to Mr. Howitt to almost require the previous existence of an undivided commune from the segmentation of which they arose.

AT the meeting of the Royal Society of Tasmania on May 20, Mr. Morton drew attention to a recent dredging trip in the harbour. The result of the dredging trip was of important interest, as the forms obtained resembled the marine fauna of Port Jackson. Among the specimens dredged were a large number of mussels, and each contained a small crab, which on examination appeared to belong to the genus Fabia. It was rather curious to learn from some of the old residents that many years back, when mussels were numerous as at present, in the majority of cases every mussel contained a crab similar to those exhibited, and that the oysters, while mussels were in large quantities, were few. Some time afterwards the mussel became nearly extinct, while the oyster multiplied. Whether that was due to this parasitical crab or not he was unable to say, but the fact was singular that while the crab was now noticeable in the mussel the oyster was increasing in numbers. Whether history would repeat itself it would be difficult to say, but it would be interesting to observe the result.

THE trustees of the State Museum of Natural History, New York, have issued their forty-first Annual Report. It is accompanied by the reports of the director, the State botanist, the State entomologist, and the State geologist. The directors call attention especially to the important and beautiful collection of minerals and gems bought for the Museum from Mr. George F. Kunz. They describe this collection as "one of the most perfect to be found in any American museum."

IN the seventh volume of the "Bulletin of the U.S. Fish Commission," lately issued, Dr. W. R. Hamilton has an interesting note on the croaking or grunting noise made by the "Perch" (*Haploidonotus grunniens*). This fish is furnished with a masticatory apparatus in the gullet, and the lower division of this has its upper surface flat and triangular in outline, and studded all over with spheroidal "teeth," if they may be called genuine teeth. The upper division is composed of two parts united by a ligament; their lower surfaces are also supplied with similar teeth. The divisions of this apparatus have powerful muscles attached to them by which they can be pressed together and moved laterally on each other. By this process the fish masticates the crustaceans on which it feeds. When this action takes place, the croaking is produced by the teeth coming in contact and gliding over each other. About twenty years ago, being interested in this subject, Dr. Hamilton procured from an Ohio River fisherman a perch weighing 18½ pounds, which he declared was the largest perch he had ever caught. Dr. Hamilton divided the head on one side, and thus exposed its masticatory apparatus; and while he moved its grinders as he supposed the fish had done during life when crushing a crawfish, an exact imitation of the croaking sound was produced.

THE Committee of the Felsted School Natural History Society, in issuing their eighth annual report, are able to congratulate the Society on a large increase of members during the past year. The members seem to give a good deal of attention to scientific study, but the Committee "continue to lament the very serious diminution of the old collecting spirit once so rife in the school, and to hope for its return." They attribute this defect to "compulsory games."

MESSRS. DEAN AND SON announce for publication "Berge's Complete Natural History of the Animal, Vegetable, and Mineral Kingdoms." It will be edited by R. F. Crawfurd, and illustrated with about 400 coloured plates and woodcuts.

PART 22 of Cassell's valuable "New Popular Educator" has been issued. The number is accompanied by a map of Africa, and there are, as usual, many illustrations.

THE new number of the Journal of the Royal Agricultural Society of England (third series, vol. i. part 2) begins with an article, by Mr. D. Pidgeon, on the development of agricultural machinery. This is followed by articles on the agricultural lessons of "the eighties," by Prof. Wrightson; the Report of the Royal Commission on Horse-breeding, by Lord Ribblesdale; tuberculosis in animals, and its relation to consumption in man, by Mr. W. Duguid; fifty years of hop-farming, by Mr. Charles Whitehead; the best means of increasing the home-production of beef, by Mr. G. Murray; and the herbage of pastures, by Dr. W. Fream.

THE Meteorological Office of Calcutta has just issued Part II. of "Cyclone Memoirs," containing a full description of a very violent cyclonic storm which passed through Bengal from August

21 to 28, 1888, written by Mr. A. Pedler. The text is accompanied by eighteen plates, giving the general meteorological conditions, and showing the track of the storm-centre day by day. Mr. Pedler states that this storm fully bears out the condensation theory of the formation of cyclones. It was formed over an area where comparatively low pressure had for some time been persistent, and there is abundant evidence of heavy rain falling over the district in which the storm was developed, and to the south of it. Several points of interest are referred to in the discussion, viz. the irregular cyclonic circulation of light winds near the centre of the storm, with a violent circulation of the clouds above these light winds, and these conditions appeared to shift their position, like an eddy; secondly, the sudden change from light winds to winds of hurricane force, extending chiefly in the southerly direction. Also the entire absence of a calm centre, and the fact that the lowest barometric pressure was recorded from ten to fourteen hours after the storm centre (as judged by the winds) had passed. The storm was remarkable for the slight barometric depression which accompanied it, considering the excessive force of the winds.

DR. R. J. SÜRING, of the Meteorological Office, Berlin, has submitted to the Friedrich-Wilhelms Universität, on the occasion of his taking his diploma, a useful paper on "the vertical decrease of temperature with height in mountainous districts, and its dependence upon the amount of cloud." In most works upon this subject, the special effect of cloud upon temperature has been limited to very moderate heights; in this paper the author has carefully investigated the observations at mountain stations up to about 4100 feet. The results arrived at are:—(1) In the morning, when the weather is clear, there is a constant tendency to an inversion of temperature. In summer this tendency extends to some 1650 feet, and in winter considerably higher. This condition recurs in the evening in a smaller degree. (2) If the sky is overcast, neither a daily nor yearly period of the vertical gradients is strongly marked. (3) A departure from the law of direct proportional decrease of temperature with height occurs chiefly during the morning hours of clear days—the change of temperature then takes place more slowly in the lower strata of air than in the upper—and on cloudy days, during the warm season, when, in the lower strata, the vertical decrease of temperature appears to be accelerated.

THE Allahabad *Pioneer* reports the result of a recent expedition to investigate the upper course of the Irawadi, the source of which, as is well known, is one of the still unsolved problems of geography. It has long been known from native report that two rivers, the Mali Kha and the Meh Kha, the former from the north, the latter from the east, unite a little below lat. 26° to form the Irawadi. The sources of the Mali Kha are known to be in the mountains to the east of the Brahmakund, which form the south-eastern water-parting of the Lohit Brahmaputra; but the Meh Kha, which is stated to be the larger stream, and which Colonel Walker supposes to be identical with the Lu River of Tibet, has never before been seen by any European. The junction of these two rivers has now for the first time been reached by an expeditionary party ascending from Bhamo. On May 27, Captain Barwick, of the Indian marine, accompanied by Mr. Shaw, the Deputy Commissioner of Bhamo, and Major Fenton, of the Intelligence Department, left Bhamo in the *Pathfinder*, a paddle-steamer of about 35 tons, with a view to reaching the point of confluence. From Bhamo as far as Maingna the stream is well known. Above Maingna the river runs between mountains from 1200 to 2000 feet high, and a succession of rapids has to be passed through, which by dint of hard struggling and after many attempts the *Pathfinder* successfully ascended, not, however, without several hairbreadth escapes from foundering, the whirlpools simply taking charge of the vessel. After six days' steaming, the party reached the confluenceof the streams, distant about 150 miles from Bhamo. Here the river was found to be 500 yards wide, one branch, the Mali Kha, trending to the north-eastward, the other, the Nmaika (Meh Kha of the map), to the eastward. Up the former the explorers proceeded some six miles, and then came upon a series of rapids. It was decided not to go further, as the small quantity of fuel remaining was reserved for steaming up the other branch. A halt of a day was made, and the position fixed in lat. 25° 56′ N., and long. 97° 38′ E. Returning to the confluence, Captain Barwick proceeded three miles up the Nmaika, when a rapid prevented further progress. The Kachins are said to have been very friendly, though they had never seen or been in communication with Europeans before.

THE recent expedition to the Bellenden Ker Range (says the *Colonies and India*) has added a long and interesting list of new specimens of Australian flora to Queensland. Since the publication of the official report the Queensland Government Botanist (Mr. F. M. Bailey) has discovered ten more new plants, making a total of forty-one species entirely new to botanical science, and the collection is not yet exhausted. There are also several specimens of mosses and lichens, which so far have remained untouched, Mr. Bailey having had no time up to the present to devote to their examination. The total number of new species will probably extend to fifty—a result far exceeding that of any previous Australian botanical expedition. In the 1889 report of the proceedings of the Linnean Society of New South Wales there is an account of four new specimens to be added to the list of those discovered by the Bellenden Ker expedition. One of these belongs to the genus *Coccincillidæ*, and has been named *Chilocorus Baileyi*, after the Queensland botanist. A large and remarkable dark blue earthworm, over seven inches long, has been named *Perichæta terræ-reginæ*—the latter a rather pedantically inflated version of *Queenslandia*. The worm was found by Mr. Meston on the top of the Herberton Range, at 2700 feet, and given to the Brisbane Museum. Two Bellenden Ker lizards of a genus new to Australian herpetology have been named by Mr. C. W. de Vis, Curator of the Queensland Museum. They belong to the order *Geckonidæ*, and are called respectively *Tropidophorus Queenslandiæ* and *Perochirus Mestoni*, the latter after the discoverer.

AN experimental study of the transpiration of plants has been recently made (we learn from *Humboldt*), by Herr Eberdt, of Marburg. The general method was to periodically weigh an air-tight vessel containing the roots of a plant (chiefly *Asclepias incarnata*, *A. Cornuti*, or *Mercurialis perennis*) in water, while the organs of transpiration projected. Absorption was also measured by means of a graduated capillary tube. We may note the following points:—The absorption and emission-values did not generally differ much. Increase of transpiration by sunlight occurred though the latter had parted with its heat-rays by passage through an alum solution; but when, after action of diffuse daylight, the dark heat-rays of sunlight (passed through a solution of iodine in carbon-sulphide) were thrown on the plants, transpiration was also increased. Direct sunlight causes more emission than absorption (shown by a relaxed appearance of the plant); and on passage into duller light, the emission falls off more quickly than the absorption, and the plant freshens. In plants with strong cuticle or few stomata, there was but little increase of transpiration from drying the air in a bell-jar over the plant by means of a dry air-current. The stomata of *Trianea bogotensis*, being watched through a microscope while light- and heat-rays were thrown on the plant from above, they were seen to open more slowly if the heat-rays were cut off; but with heat-rays alone they remained closed. If opened in light, they remained open when the heat-rays acted alone, and closed when these too were stopped. A sooty metallic plate at 30° to 25° held 3 to 5 seconds over the leaf opened the stomata, while dark heat-rays of sunlight failed to do so. The stomata opened also on passing a stream of warm, nearly saturated, air over the leaves. A shaking of plants acts not by way of shock, but by changing the atmosphere about the leaves, and therefore like wind. Strong shaking stimulates transpiration; while weak vibration has no perceptible effect. The effect of wind was studied by directing air-currents of measured strength on the plants. The action of the weaker currents proved proportionally greater than that of stronger. The transpiration is greater if the leaves are free to be moved than if they are fixed.

THE additions to the Zoological Society's Gardens during the past week include two Ravens (*Corvus corax*), British, presented by Mr. Walter Chamberlain, F.Z.S.; two Wheatears (*Saxicola œnanthe*), two Whinchats (*Pratincola rubetra*), two Great Tits (*Parus major*), British, presented by Mr. J. Young, F.Z.S.; a Cuckoo (*Cuculus canorus*), British, presented by Mr. Valentine Marks; a Black Tortoise (*Testudo carbonaria*) from Jamaica, presented by Master Morris Blake; a Dwarf Chameleon (*Chamæleon pumilis*) from South Africa, presented by Mr. H. Tholen; a Brazilian Hangnest (*Icterus jamaicai*), two Bluish Finches (*Spermophila cœrulescens*), a Tropical Seed-Finch (*Oryzoborus torridus*), a Thick-billed Seed-Finch (*Oryzoborus crassirostris*) from Brazil, a Black-faced Kangaroo (*Macropus melanops* ♂) from South Australia, deposited; a Thar (*Capra jemlaica* ♀), two Mule Deer (*Cariacus macrotis* ♀ ♀), five Cuming's Octodons (*Octodon cumingi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on July 31 = 18h. 37m. 53s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 4447	—	Bluish-green.	18 49 27	+32 53
(2) D.M. + 31° 3199 ...	5	Yellowish-red.	18 7 46	+31 23
(3) 70 Ophiuchi	4	Yellow.	17 59 54	+ 2 32
(4) o Herculis	4	Bluish-white.	18 3 18	+28 45
(5) 219 Schj.	8	Red.	18 43 57	− 8 1
(6) V Coronæ	Var.	Yellowish-red.	15 45 35	+39 54

Remarks.

(1) The well-known Ring Nebula in Lyra, which has been described in great detail by various observers. The spectrum consists of bright lines, but the line near λ 500 is the only conspicuous one. When the image of the nebula is sharply focussed on the slit, the chief line is seen as two bright dots connected by a faint line, indicating that nebulous matter fills the interior of the ring. (This is also confirmed by the telescopic appearance.) The line F and the one near λ 495 are exceedingly faint, but they are undoubtedly present. In my own observations, with a 10-inch refractor, I have also glimpsed a less refrangible line, but have not been able to determine its position with any degree of accuracy. Further investigation of this line should be made with as large an aperture as possible. It is not far from *b*.

(2) D'Arrest and Dunér agree in describing the spectrum of this star as one of Group II. with well-developed bands. The bands at the red end are the strongest, indicating that the star is well advanced in condensation. The bands in the red are the last to disappear in passing to stars like α Tauri, and hence this conclusion. As in similar stars, the line absorptions at this stage afford an interesting study. We do not know yet, for instance, the stage at which the hydrogen lines first appear, although we now certainly know that they are present in α Orionis. The same also applies to D and *b*.

(3) The integrated spectra of the components of this double star present an appearance similar to that of a well-developed star of the solar type. No attempt has apparently yet been made to separate the two spectra. This should be done, if possible, and the usual more detailed observations as to whether the temperature is increasing or decreasing should be made.

(4) A star of Group IV. (Gothard).

(5) According to the observations of Dunér, this star has a fine spectrum of Group VI., the principal bands being very wide and dark. In addition to these, the secondary bands 4 and 5 (λ 589 and 576 respectively) were easily seen, and band 2 (λ 621) was also feebly visible. What is most required in this group of stars is a very detailed examination with the largest possible apertures. If such be undertaken, particular attention should be given to the presence or absence of line absorptions.

(6) This variable is chiefly of interest because its spectrum is one of Group VI. We have as yet no knowledge, as we have in the case of variables of Group II., of the variations of spectrum which accompany the increase of light at maximum. The range of variation in V Coronæ is very considerable—7·5 to 12 in a period of about 357 days; and it is not unlikely that well-marked changes may take place in the spectrum. Dunér states that the carbon band near λ 564 is weaker than that near λ 517, and that the secondary bands are not visible; but he gives no indication of the magnitude of the star at the time of his observation. Prof. Lockyer's investigations appear to indicate that the dark carbon bands should be proportionately less strongly marked at maximum than at minimum. There will be a maximum about August 5.

A. FOWLER.

DISTRIBUTION OF THE PERIHELIA OF COMETS.—In 1880, Dr. Henry Muirhead directed attention to the arrangements which the perihelia of comets exhibit in relation to the sun's line of flight, and pointed out that, taking the twenty-two comets given in the "Encyclopædia Britannica" along with thirteen others whose elements were given in NATURE up to the date of his communication, and arranging them according to their heliocentric longitudes, the perihelia were seen to be crowded into the quadrants which the sun's line of flight bisects, as compared with those taking place in the quadrants flanking the said line (Proceedings of the Philosophical Society of Glasgow, vol. xiii.). By examining the succeeding volumes of NATURE, Dr. Muirhead has obtained the heliocentric longitudes of the perihelia of forty-one more comets, and in a communication to the Philosophical Society of Glasgow, on February 5, 1890, he showed that they also exhibit the same tendency to cluster near heliocentric longitudes 263° and 83°—that is, the longitude of the "apex" and "quit" of the sun's way adopted by him.

It will be remembered that Mr. H. S. Monck, in a letter to the *Observatory*, in December 1888, remarked that, in examining catalogues of comets, he found 177 comets with perihelia north of the ecliptic, against 115 with southern perihelia. With respect to this circumstance, Mr. Monck wrote:—"Our observing stations are chiefly situated in northern latitudes. Comets are rarely visible when very remote from their perihelia; therefore, comets which pass their perihelia north of the ecliptic are more likely to be detected and observed than comets which pass their perihelia to the south of it. . . . As the point towards which the sun is moving lies to the north of the ecliptic, it might be expected that more comets would, on the whole, come to us from the north than from the south. But a comet coming from the north will usually have its aphelion north and its perihelion south. The fact that three-fifths of the comets have their perihelia to the north and their aphelia to the south thus becomes more significant, and I can hardly regard it as *wholly* the result of the position of our observing stations."

Later, however (August 1889), Dr. Holetschek drew attention to a pamphlet "Ueber die Richtungen der grossen Axen der Cometenbahnen," in which he shows that "the tendency of comet perihelia or aphelia to accumulate rather in small latitudes, and about the longitudes 90° and 270° than in other places, can be explained by purely terrestrial considerations, and, consequently, this accumulation offers no proof of the motion of the solar system or of the ultra-solar origin of comets." In fact, it appears that the distribution in latitude of the perihelia of comets is nearly uniform, and has not a marked maximum in the latitudes of the sun's line of flight, although, as Dr. Muirhead indicates, a clustering of aphelia and perihelia occurs near the heliocentric longitude of the line.

THE ROCKS OF THE MOON.—M. Landerer, in continuation of his memoir last year on the polarizing angle of the lunar surface, has just communicated to the Paris Academy the results of some determinations of the angle of polarization of igneous rocks. He finds that specimens from different localities give practically identical results, the probable errors never being greater than ± 5′. The polarizing angle increases from 30° 51′ for ophite, through syenite, basalt (31° 43′), serpentine, trachyte, granite (32° 20′), diorite, diabase, andesite (32° 50′), to obsidian (33° 46′). Vitrophyre, a black rock from the Rhodope chain, which contains large crystals of sanidine, magnetite, and hornblende, in a fluidal, non-perlitic matrix, has a polarizing angle of 33° 18′, which approximates very closely to that of the lunar surface. Without presuming too much on this result, the author regards it as at any rate an additional proof of the similarity, and therefore common origin, of our earth and its satellite. The fact that the polarizing angle of ice is more than 37°, is another objection to M. Hirn's hypothesis of lunar glaciation.

BROOKS'S COMET (*a* 1890).—Dr. Bidschof gives the following ephemeris in *Astronomische Nachrichten*, No. 2979:—

Ephemeris for Berlin Midnight.

1890.	R.A. h. m. s.	Decl.	Log *r*.	Log Δ.	Brightness.
Aug. 1	13 11 1	+45 37·9	0·3121	0·3714	1·38
5	13 7 39	43 57·9	0·3160	0·3849	1·27
9	13 5 4	42 24·2	0·3200	0·3978	1·18
13	13 3 9	40 56·5	0·3242	0·4100	1·09
17	13 1 45	39 34·5	0·3285	0·4215	1·02
21	13 0 47	38 17·7	0·3330	0·4323	0·95
25	13 0 12	37 5·8	0·3376	0·4423	0·89
29	12 59 58	35 58·6	0·3422	0·4517	0·83
Sept. 2	12 59 54	34 56·1	0·3470	0·4605	0·78

The brightness on March 21 has been taken as unity.

BRORSEN'S COMET.—Mr. E. Barnard, of Lick Observatory, notes, in the above number of *Astronomische Nachrichten*, that he has made many searches for this comet from December of last year to the end of April, but with only a negative result. He notes that during the search he has found several unrecorded nebulæ.

TWO NEW COMETS (*b* and *c* 1890).—M. Coggia, at Marseilles, has discovered a pretty bright comet having the following positions (*Astronomische Nachrichten*, 2980).

Marseilles Mean Time. h. m.	R.A. h. m. s.	Decl. ° ′ ″
July 18 ... 10 31·0	8 48 51·0	+44 42 48
19 ... 9 38·8	8 55 58	44 2 48

Mr. Denning discovered a faint comet at Bristol on July 23; its position at 13 hours Greenwich mean time being R.A. 15h. 12m., and Decl. +78°. It was moving towards the east (*Edinburgh Circular*, No. 8).

A NEW ASTEROID (294).—M. Charlois, of Nice Observatory, discovered an asteroid of the twelfth magnitude on the 15th inst.

THE SCIENTIFIC PRINCIPLES INVOLVED IN MAKING BIG GUNS.

II.

PART II.—THE STRAINS IN THE GUN.

(29) SO far we have dealt only with the stresses in the metal, and we have determined these stresses in the manner given by Rankine in his "Applied Mechanics," § 273, p. 290, in which the only assumption made is that the metal of each cylinder is homogeneous. But when the gun-maker wishes to set up a given pressure of shrinkage between two cylinders, he has to determine, by calculation or experiment, the slight amount by which, when cold, the external radius of one cylinder must exceed the internal radius of the next cylinder which is shrunk on it; the outer cylinder being expanded by heat and slipped on, in order that the given initial pressure may be set up on the cooling of the outer cylinder; and this, too, when other cylinders are shrunk on afterwards.

We must therefore determine the strains and deformations set up in a given cylinder due to given applied pressures, and thus we require the equations giving the strains due to given applied stresses when the coefficients of elasticity of the metal are known.

(30) Now, it is proved in Thomson and Tait's "Natural Philosophy," §§ 682, 683, for a substance of which k is the elasticity of volume or bulk-modulus, and n is the elasticity of figure or rigidity, that when the stress is a simple longitudinal tension P, the principal strains in the substance are an extension $P\left(\frac{1}{3n} + \frac{1}{9k}\right)$ in the direction of the tension, and a compression $P\left(\frac{1}{6n} - \frac{1}{9k}\right)$ in all directions perpendicular to the tension.

We use the words *tension* and *pressure*, as before, to denote *stresses* measured in terms of pull or thrust per unit area, with our practical units, measured in tons per square inch; while the words *extension* and *compression* are used (in accordance with the terminology of Maxwell, Everett, and Unwin) to mean the *strains*, measured by the ratio of linear elongation or contraction to the original length.

Thus, the *tension* or *pressure* being the *stress*, the *extension* or *compression* is the corresponding *strain*; and Hooke's law of elasticity (*ut tensio sic vis*), translated into a formula, gives $\frac{\text{stress}}{\text{strain}} = \frac{\text{tension}}{\text{extension}} = \frac{\text{pressure}}{\text{compression}}$ = the modulus of elasticity.

(31) Then, by superposition, if e, f, g are the extensions produced in three rectangular directions by tensions P, Q, R in these directions—

$$e = \left(\frac{1}{3n} + \frac{1}{9k}\right)P - \left(\frac{1}{6n} - \frac{1}{9k}\right)(Q + R), \quad . \; . \; (31)$$

with two similar expressions for f and g; or, in Thomson and Tait's notation, § 694—

$$Me = P - \sigma(Q + R), \quad . \; . \; . \; . \; . \; . \; (32)$$
$$Mf = Q - \sigma(R + P), \quad . \; . \; . \; . \; . \; . \; (33)$$
$$Mg = R - \sigma(P + Q), \quad . \; . \; . \; . \; . \; . \; (34)$$

where

$$\frac{1}{M} = \frac{1}{3n} + \frac{1}{9k}, \text{ or } M = \frac{9nk}{3k + n},$$

so that M is Young's modulus of elasticity, the modulus which is directly observable when a test-piece of the substance (steel) is placed in a testing-machine, and the ratio $M = P/e$ is observed of P, the tension, to e, the extension, no lateral tension being applied, or

$$Q = 0, \; R = 0;$$

also,

$$\sigma = \frac{3k - 2n}{6k + 2n},$$

called Poisson's ratio, is the ratio of the lateral compression to the linear extension of the substance when the stress is a simple tension.

(32) Again, by independent investigation, as in § 692, or by solution of the preceding equations (32, 33, 34), we find—

$$P = \left(k + \frac{4}{3}n\right)e + \left(k - \frac{2}{3}n\right)(f + g), \quad . \; . \; (35)$$
$$Q = \left(k + \frac{4}{3}n\right)f + \left(k - \frac{2}{3}n\right)(g + e), \quad . \; . \; (36)$$
$$R = \left(k + \frac{4}{3}n\right)g + \left(k - \frac{2}{3}n\right)(e + f); \quad . \; . \; (37)$$

or, in Lamé's notation ("Théorie de l'Élasticité," § 19)—

$$P = \lambda\theta + 2\mu e,$$
$$Q = \lambda\theta + 2\mu f,$$
$$R = \lambda\theta + 2\mu g,$$

with

$$\theta = a + b + c,$$

the cubical expansion; and

$$\lambda = k - \frac{2}{3}n, \; \mu = n.$$

The above equations show that when the strain is given as a simple uniform longitudinal extension e, the stresses consist of a uniform longitudinal tension, $(k + \frac{4}{3}n)e = (\lambda + 2\mu)e$, in the direc-

[1] Continued from p. 309.

tion of the strain, and of uniform lateral tension, $(k - \frac{2}{3}n)e = \lambda e$, in every direction perpendicular to the strain.

(33) These equations, and the previous equations, which show that, when the stress is a simple uniform longitudinal tension P, the strains consist of a uniform extension P/M in the direction of the tension, and of uniform lateral compression σP/M perpendicular to the tension, are so fundamental in the theory of the elasticity of isotropic bodies, that we are almost tempted to make a digression here on their proof, in the manner given in Thomson and Tait's "Natural Philosophy," §§ 682, 683, and 692.

It is necessary to describe and compare the notations carefully, for subsequent purposes, as the variety of notation in the subject of elasticity is very confusing.

(34) Applying these principles to the gun, we take the three principal directions of stress and strain, as (i.) circumferentially to the gun, (ii.) radially, (iii.) longitudinally; and now, estimating *tensions* and *extensions* as positive, we have—

$$P = \quad t = \quad ar^{-2} - b,$$
$$Q = -p = -ar^{-2} - b;$$

while the value of R is still indeterminate.

For the determination of the strains, we denote by u the *increase* of radius, r, of a circumferential fibre; and then $2\pi u$ being the elongation of the fibre of original length $2\pi r$, the circumferential extension

$$e = 2\pi u/2\pi r = u/r;$$

while the radial extension $f = du/dr$; the longitudinal extension g being as yet undetermined.

(35) Expressing the strains e and f in terms of the longitudinal tension R,

$$Me = Mu/r = P - \sigma(Q + R)$$
$$= ar^{-2} - b + \sigma(ar^{-2} + b) - \sigma R$$
$$= (1 + \sigma)ar^{-2} - (1 - \sigma)b - \sigma R;$$

or

$$Mu = (1 + \sigma)ar^{-1} - (1 - \sigma)br - \sigma Rr; \quad . \quad . \quad . \quad (38)$$

so that, differentiating with respect to r,

$$Mf = Mdu/dr$$
$$= -(1 + \sigma)ar^{-2} - (1 - \sigma)b - \sigma d(Rr)/dr$$
$$= Q - \sigma P - \sigma d(Rr)/dr.$$

But with

$$Mf = Q - \sigma(R + P),$$

Barlow, Lamé, and Hart's expressions for the stresses are verified, provided that

$$d(Rr)/dr = R;$$

or

$$dR/dr = 0, \qquad R = \text{constant}.$$

(36) On the other hand, expressing the strains e and f in terms of the longitudinal strain or extension g, since

$$R = \sigma(P + Q) + Mg,$$
$$Me = Mu/r = P - \sigma(Q + R)$$
$$= (1 - \sigma^2)P - \sigma(1 + \sigma)Q - \sigma Mg$$
$$= (1 - \sigma^2)(P - \sigma'Q) - \sigma Mg,$$

putting

$$\sigma' = \frac{\sigma}{1 - \sigma};$$

so that

$$Mu = (1 - \sigma^2)\{(1 + \sigma')ar^{-1} - (1 - \sigma')br\} - \sigma Mgr; \quad . \quad (38^*)$$

and differentiating with respect to r,

$$Mf = Mdu/dr$$
$$= (1 - \sigma^2)(Q - \sigma'P) - \sigma Md(gr)/dr,$$

agreeing again in giving

$$Mf = Q - \sigma(R + P,$$

provided that

$$d(gr)/dr = g;$$

or

$$dg/dr = 0, \qquad g = \text{constant}.$$

We have proved, then, that either the longitudinal tension R or the longitudinal extension g of the gun must be uniform, for the values of the stresses given by the formulas of Barlow, Lamé, Hunt, and Rankine, to be strictly accurate; we shall follow the ordinary practice in assuming that R is uniform, but the work will be almost precisely the same if we assume that g is uniform (Prof. P. G. Tait, "On the Accurate Measurement of High Pressures," Proc. R.S. Edinburgh, 1879–80).

(37) Now, let us determine, for the simplest case of the tube A and the jacket B, the requisite *shrinkage* for producing a given initial pressure $\varpi_o = p_i$ at their common surface; the shrinkage, denoted by S, being defined as the excess of the outside diameter $2\rho_o$ of the tube A over the inside diameter $2r_i$ of the jacket B, when both are finished cold in the lathe; so that

$$\tfrac{1}{2}S = \rho_o - r_i.$$

The jacket B is now expanded by heat till its inside diameter is greater than $2\rho_o$, and then slipped over the tube A; on cooling, the jacket B shrinks and grips the tube A with the requisite pressure, $p_i = \varpi_o$.

Taking the practical rule that the expansion of steel is one-ten-thousandth for every 15° F., the jacket must be raised in temperature something over 150,000 $S/2r_i$ degrees Fahr.

Denoting by u and v the outward displacement of any circumferential fibre of the jacket or tube, of radius r in the jacket and ρ in the tube; then, since the tube and jacket fit closely at their common surface,

$$\rho_o + v_o = r_i + u_i,$$

or

$$u_i - v_o = \rho_o - r_i = \tfrac{1}{2}S.$$

(38) Supposing the tube and jacket to be both of steel of the same quality, so that M, the modulus of elasticity, is the same for both; and assuming that R is uniform, then in the jacket B, from (38),

$$Mu_i = (t_i + \sigma p_i)r_i - \sigma Rr_i,$$

and in the tube A,

$$Mv_o = (-\tau_o + \sigma\varpi_o)\rho_o - \sigma R\rho_o;$$

and now, since $p_i = \varpi_o$, and we may put $r_i = \rho_o$, subtraction gives—

$$M(u_i - v_o) = (t_i + \tau_o)r_i,$$

or

$$S = (t_i + \tau_o)2r_i/M; \quad . \quad . \quad . \quad . \quad . \quad (39)$$

and t_i and τ_o having been determined either from the formulas (6) to (16), or graphically from Fig. 3, from the given value of $p_i = \varpi_o$, the requisite value is determined of the shrinkage S, or of $S/2r_i = (t_i + \tau_o)/M$, which is the shrinkage, estimated as a fraction of the diameter.

This formula shows us that the shrinkage S is the elongation or contraction which would be produced in a bar of steel, one square inch in section, and equal in length to the diameter $2r_i$, by a pull or thrust of $t_i + \tau_o$ tons.

If we had taken g as uniform, we should find in a similar manner—

$$S = (1 - \sigma^2)(t_i + \tau_o)2r_i/M. \quad . \quad . \quad . \quad . \quad (40)$$

With steel, $\sigma = \frac{1}{4}$ about, so that $\sigma' = \frac{1}{3}$; and the values of the shrinkage calculated on the two assumptions of uniform R and uniform g, would be in the ratio of 1 to $1 - \sigma^2$, or as 16 to 15; thus differing by about 6 per cent., a difference which is practically insensible.

(39) In the numerical example we have given of the initial stresses of the tube and jacket, $t_i = 5$, $\tau_o = 5$; so that $S/2r_i = 10/M$.

For gun steel M = 12,600 about (Unwin, "Testing of Materials of Construction," p. 249); and supposing the tube and jacket to represent a 3-inch field gun, $2r_i = 6$; and then

$$S = 1/210 = 0{\cdot}00476,$$

4·76 thousands of an inch.

(40) In heavy guns, one or more hoops are shrunk on over the jacket; for instance, in the 110-ton gun, three such series are superposed. Diagrams in section of modern guns will be found in recent numbers of the *Engineer* and of *Engineering*.

The addition of each hoop that is shrunk on modifies the initial stresses previously existing. The annexed diagram (Fig. 7), taken from the American "Notes on the Construction of Ordnance," Nos. 31, 33, 35, by Lieutenant Rogers Birnie, shows the shrinkage (enlarged 50 times) of the different parts, and the intermediate and final arrangements when a jacket, B, an inner hoop, C, and an outer hoop, D, are successively shrunk on the tube A of the American 8-inch gun, shown in longitudinal section in Fig. 8.

But knowing the initial stresses in the gun, as determined in the manner already explained in Part I., we can determine the requisite shrinkage at each common surface, for any number of layers, by a formula as simple as that just found for the tube A and jacket B, if only we assume that M, the modulus of elasticity, is the same throughout.

(41) Denote, as before, by p_m, the radial pressure at the radius, r_m, of the common surface of the mth and $m + 1$th hoops, as reckoned from the interior; and by t'_m, t_m the circumferential tensions at the exterior radius, r_m, of the mth hoop, and at the interior radius, r_m, of the $m + 1$th hoop.

Denote also by u'_m, u_m, the outward radial displacement from the unstrained position of the outer surface of the mth hoop, and of the inner surface of the $m + 1$th hoop.

Then, with uniform R, from (38),

$$Mu_m = (t_m + \sigma p_m)r_m - \sigma R r_m,$$

$$Mu'_m = (t'_m + \sigma p_m)r_m - \sigma R r_m;$$

so that

$$M(u_m - u'_m) = (t_m - t'_m)r_m.$$

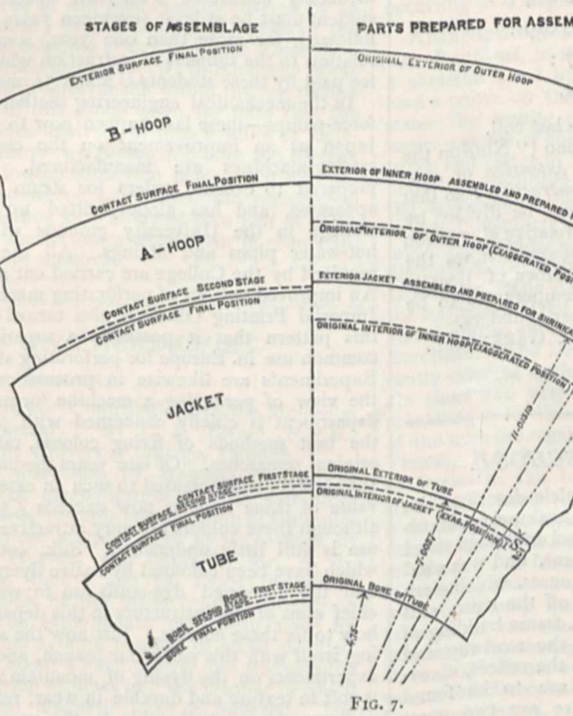


FIG. 7.

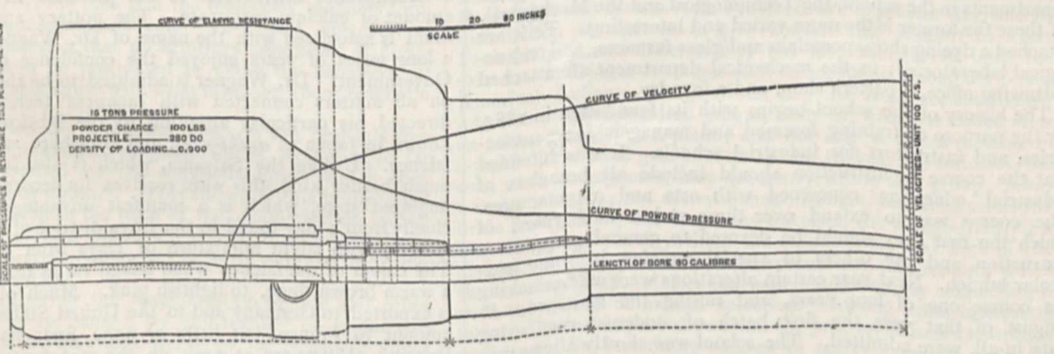


FIG. 8.

Now, using the notation ${}_mS_{m+1}$ to denote the shrinkage when unstrained between the mth and $m + 1$th hoops,

$${}_mS_{m+1} = 2(u_m - u'_m)$$

$$= (t_m - t'_m)2r_m/M, \quad . \; . \; . \; . \quad (41)$$

the same as for a single tube, A, and jacket, B; and showing that the shrinkage, ${}_mS_{m+1}$, is the elongation or contraction which would be produced in a bar of steel, of modulus of elasticity M, one square inch in section, and of length equal to the diameter $2r_m$, by a pull or thrust of $t_m - t'_m$ tons. On the assumption of uniform g, we should find—

$${}_mS_{m+} = (1 - \sigma^2)(t_m - t'_m)2r_m/M, \quad . \; . \; . \quad (42)$$

practically the same as for uniform R.

(42) The stress formulas in the mth hoop give—

$$2a_m = (p_m + t'_m)r_m^2 = (p_{m-} + t_{m-1})r^2_{m-1}.$$

$$2b_m = (p_m - t'_m = p_{m-1} - t_{m-1};$$

so that

$$t_m - t'_m = (t_m - t_{m-1}) - (p_m - p_{m-1}).$$

These values of t_m and t'_m are the initial stresses or circumferential tensions; and as the powder pressure p_0 increases them by equal amounts, their difference is unaltered; so that $t_m - t'_m$ is the same for the initial stresses or the firing stresses; and we may calculate the shrinkage, S, by the above formula from the values of the firing stresses, or of the initial stresses; the former being chosen, as given more directly when the maximum allowable tensions, represented by t_m, are given.

(43) As a numerical illustration, let us calculate the shrinkages in the American 8-inch gun, taking the previous results of § 22, and M = 12,600 (tons per square inch) for all the coils.

Then the final contraction of the bore

$$ {}_0S_1 = t_0 \times 2r_0 \div M = 19{\cdot}9 \times 10 \div 12{,}600 = 0{\cdot}016, $$

or 16 thousandths of an inch; and similarly,

$$ {}_1S_2 = 12{\cdot}7 \times 14 \div 12{,}600 = 0{\cdot}014 ; $$
$$ {}_2S_3 = 10{\cdot}7 \times 22 \div 12{,}600 = 0{\cdot}019 ; $$
$$ {}_3S_4 = 3{\cdot}6 \times 26 \div M = 0{\cdot}007 ; $$
$$ {}_4S_5 = 8{\cdot}1 \times 32 \div M = 0{\cdot}021, $$

the elongation of the external diameter of the last coil.

Lieutenant Rogers Birnie, following Clavarino ("Note on the Construction of Ordnance," No. 6), calls the *extension* or *compression* the *relative elongation* or *relative contraction*; so that the above values of ${}_0S_1$, ${}_1S_2$, ${}_2S_3$, ${}_3S_4$, ${}_4S_5$, must be divided by 10, 14, 22, 26, 32, to obtain his values of the relative elongation or contraction; and then, by § 37, 150 thousand times the relative elongation or contraction is the number of degrees Fahrenheit a jacket or coil must be raised in temperature to be expanded sufficiently so as to slip over the inner cylinders.

A. G. GREENHILL.

(*To be continued.*)

THE TOKIO TECHNICAL SCHOOL.

THE *Japan Weekly Mail* in a recent article describes the Tokio Technological School, situated at Asakusa, a suburb of that city. The inclosure in which the school buildings stand formerly belonged to the Shôgun's Government, and was used for the storage of rice. Several of its storehouses, which were ranged round a creek or blind canal leading off the river, still remain, and are utilized by the institution. A frame building of two stories, the chief modern portion, faces the roadway and runs at right angles to the creek. Here are the offices, show-rooms, and lecture-rooms; the workshops are to be found between this building and the river. There are two great departments in the school, the Technological and the Mechanical. Of these the former is the more varied and interesting. To it are attached a dyeing shop, porcelain and glass furnaces, and technological laboratories; to the mechanical department are attached a drawing office, a pattern shop, and a foundry.

The history of the school begins with its foundation in 1882, for the purpose of training foremen and managers for manufactories, and instructors for industrial schools. It was intended that the course of instruction should include all branches of industrial education concerned with arts and manufactures. The course was to extend over three and a half years, of which the first year should be devoted to general preparatory instruction and the others to special training in some particular branch. Next year certain alterations were made, making the course one of four years, and raising the standard. In August of that year the first batch of students, numbering sixty in all, were admitted. The school was shortly afterwards brought into connection with the Imperial University, and placed under the control of that institution—a step which led to a complete change in its curriculum. The preparatory course was abolished, and a short complete course, extending over two years, was instituted. Again, in 1888, a new Imperial decree severed its connection with the University, and placed it under the direct control of the Education Department. The school set itself anew to remodel its course of instruction, abolishing the short general course and resuming the course of three years; and elective courses were established with the view of making the school more popular and generally useful to mechanics and craftsmen. The laboratories and workshops are each provided with responsible superintendents, foremen, and assistants. The general direction is in the hands of a Committee, consisting of the manager of the school, two officials of the Education Department, and two officials of the Department of Agriculture and Commerce. Candidates for entrance to the regular courses must be not under seventeen nor over twenty-five years of age, and unless they have passed satisfactorily through a normal or middle school, must undergo an examination in Japanese, arithmetic, algebra and geometry, physics and chemistry, and English translation. Students sent up by local governments need not undergo this examination. The elective courses have been instituted for the benefit of artisans and mechanics, who, having no general scientific training, are anxious to study some part of the regular course. These candidates receive this privilege only when the convenience of the school admits of it, and are allowed to study for two years, taking one or more of the subjects immediately connected with their special crafts. An elective student must be at least seventeen years of age, and must have followed, for more than one year, some trade having special relation to the subjects of instruction which he has chosen. The fee paid by these students is about 3*s*. monthly.

In the mechanical engineering section-boilers, steam-engines, force-pumps—these last happen now to be in great demand in Japan as an improvement on the clumsy well-bucket—and sawing-machines are manufactured. The shop is also prepared to execute orders for steam and hot-water heating apparatus, and has already fitted up the new Engineering College in the University grounds with a complete set of hot-water pipes and fittings. All the casting and founding required by the College are carried out at the Asakusa School. An improved pattern of perforating machine, now in use at the Imperial Printing Office, is also turned out. It is claimed for this pattern that it possesses a superiority over the one in common use in Europe for perforating stamps and other paper. Experiments are likewise in process on printing-presses, with the view of perfecting a machine for native use. The dyeing department is chiefly concerned with practical instruction in the best methods of fixing colours, rather than in any more original researches. Of late years the importation into Japan of aniline dyes has increased to such an extent that the total annual value of these imports now exceeds £35,000. Unfortunately, although these colours are very attractive to buyers, their proper use is still little understood. Silk, cotton, and other fabrics which have been coloured by native dyers do not wash well, and half the imported dye-stuffs run to waste. It is one of the chief aims of the instructors in this department to teach artisans how to fix these colours. Just now the school dye-shop is busying itself with this particular branch, and also with a series of experiments on the dyeing of mountain silk. This silk, which is soft in texture and durable in wear, refuses the ordinary dye, a circumstance attributable to the presence in it of a large amount of calcium carbonate. The pottery and glass department is associated with the name of Dr. Wagner, who has for a long series of years enjoyed the confidence of the Japanese Government. Dr. Wagner is admitted to be the best authority on all matters connected with Japanese technology, and has directed his particular attention to the fabrication of a ware known in Japan as *asahi-yaki*, and elsewhere as Dr. Wagner's faience. Unlike the Satsuma, which is also faience, but of a much harder kind, this ware receives its decoration when in its unglazed state, which is a manifest advantage. It is made chiefly from a clay found in the Enya district of the Tochigi prefecture, with slight admixture of clays from other localities. The colour of the faience when baked varies from white, having a warm brown tinge, to lightish pink. Much of the *asahi-yaki* is exported to Germany and to the United States, and a certain amount to France, but little or none finds its way to Great Britain. Artists are at work on the spot decorating the plates and other articles preparatory to the receiving of the glaze. The object which Dr. Wagner and his colleagues have in view is technological and not artistic, and consists in perfecting native potters in the manipulation of the material.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for June 1890 contains:—On the embryology of a scorpion (*Euscorpius italicus*), by Malcolm Laurie (Plates xiii.-xviii.). The development of this scorpion, of which very elaborate details are given, would appear not to agree closely with any other Arachnid type as yet described; the development of the central and lateral eyes entirely confirms the descriptions of Lankester and Bourne, as well as those of Parker, but Patten's conclusions are shown to be without foundation. The mode of formation of the ventral nervous system is exceptional among Invertebrates, resembling rather that of Chordata.—On the morphology of the compound eyes of Arthropods, by S. Watase (Plate xix.). Reprinted, with a short introduction by the editor, from a recent number of the "Studies from the Biological Laboratory, Johns Hopkins University."—On the structure of a species of earthworm belonging to the genus Diachæta, by Frank Beddard (Plate xx.). This new species, *D. windlei*, is from the Bermudas.—On *Hekaterobranchus shrubsoli*, a new genus and species of the family Spionidæ, by Florence Buchanan (Plates xxi. and xxii.). This worm was found at Sheppey in soft mud, usually covered by an inch or so of brackish water; in addition to the figures of the anatomical details there are coloured portraits of this Annelid.—An attempt to classify earthworms, by Dr. W. B. Benham. Some idea may be formed of the progress made within the last twenty years in our knowledge of this group when we state that the author enumerates and gives analyses of nine families of Lumbricomorpha, containing thirty-two genera and over 200 species. The author wishes the following correction made:—In Fig. 39, which illustrates the anatomy of Lumbricus, the œsophageal pouch (CP) is placed in somite xi.; followed by a pair of calciferous glands in the same somite and a second pair in somite xii. The pouch (CP) should be in somite x.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 19.—"Contributions to the Molecular Theory of Induced Magnetism." By J. A. Ewing, F.R.S., Professor of Engineering in University College, Dundee.

After referring to the discussion by Maxwell of Weber's theory, which ascribes the magnetization of iron and other magnetic metals to the turning towards one direction of molecules which are already permanent magnets, and to suggestions by Profs. Wiedemann and Hughes, and lately by Mr. A. E. Kennelly (the *Electrician*, June 6 and 13, 1890), the writer describes experiments which he has made bearing directly on the molecular theory. The experiments have been made by grouping near to one another a large number of small pivotted magnets each free to turn about a fixed centre, and studying the configuration which the group assumes and the manner in which it yields when an external magnetic force is imposed. The results do not support the idea that the molecular magnets form closed chains in unmagnetized iron. They lead, however, to the important conclusion that no arbitrary conditions of directional constraint need be postulated to make the behaviour of the molecular magnets agree with what is known about magnetic quality.

In the writer's view the molecular magnets are perfectly free to turn in response to external magnetic forces, except in so far as they are constrained by the magnetic forces which they mutually exert on one another. This theory is briefly discussed in the paper in relation to the form of the magnetization curve, to the character of cyclical processes, and to the known effects of temperature, vibration, stress and so forth, and the following conclusions are stated:—

(1) That in considering the magnetization of iron and other magnetic metals to be caused by the turning of permanent molecular magnets, we may look simply to the magnetic forces which the molecular magnets exert on one another as the cause of their directional stability. There is no need to suppose the existence of any quasi-elastic directing force or of any quasi-frictional resistance to rotation.

(2) That the intermolecular magnetic forces are sufficient to account for all the general characteristics of the process of magnetization, including the variations of susceptibility which occur as the magnetizing force is increased.

(3) That the intermolecular magnetic forces are equally competent to account for the known facts of retentiveness and coercive force, and the characteristics of cyclic magnetic processes.

(4) That magnetic hysteresis and the dissipation of energy which hysteresis involves are due to molecular instability resulting from intermolecular magnetic actions, and are not due to anything in the nature of frictional resistance to the rotation of the molecular magnets.

(5) That this theory is wide enough to admit explanation of the differences in magnetic quality which are shown by different substances, or by the same substance in different states.

(6) That it accounts in a general way for the known effects of vibration, of temperature and of stress, upon magnetic quality.

(7) That, in particular, it accounts for the known fact that there is hysteresis in the relation of magnetism to stress.

(8) That it further explains why there is, in magnetic metals, hysteresis in physical quality generally with respect to stress, apart from the existence of magnetization.

(9) That, in consequence, any not very small cycle of stress occurring in a magnetic metal involves dissipation of energy.

Anthropological Institute, June 24.—E. W. Brabrook, Vice-President, in the chair.—Mr. J. E. Price exhibited parts of a skeleton found at West Thurrock, Essex.—Mr. H. H. Risley read a paper on the study of ethnology in India. This paper states the results of certain inquiries into the customs and measurements of the features, stature, &c., of some of the chief tribes and castes in India, conducted during the last five years under the authority of the Government of Bengal. Owing to the influence of the caste system, which forbids intermarriage between members of different castes, India offers a peculiarly favourable field for anthropological researches. The measurements disclose the existence of two extreme types—the Aryan and Dravidian. The Aryan type—as represented by the Brahmans, the Rajputs, and the Sikhs—is tall and fair, with a finely cut nose, and features on the whole superior to those of the average European. The Dravidians, as seen in the Kol tribes, who recently revolted against the oppression of their Hindu landlords, are short and very black, with a broad flat nose, closely approaching in its dimensions to that of the Negro. The proportions of the nose are regarded by European anthropologists—by Prof. Flower, F.R.S., of the British Museum, and Prof. Topinard, of Paris—as the best test of race distinctions. The Indian statistics bear out this opinion. They show that in Bengal caste is so closely connected with race that the social standing of a caste is in inverse ratio to the average width of the noses of its members. The lower the caste the broader and more Negro-like is its nose; and conversely, in ascending the social scale, we meet with continually finer noses, till in the higher castes European proportions are reached. The proportions of the head are of interest in connection with the theory propounded by Herr Karl Penka, of Vienna, and favoured by Prof. Sayce, that the Aryans were a dolichocephalic (long-headed) race who came originally from Scandinavia. The long-headed type is very numerous in the Punjab and North-West Provinces at the present day, and its distribution is such as to give considerable support to Herr Penka's opinions. The inquiry has also brought to light the existence in Bengal of totems such as are found among the North American Indians. Large tribes, like the Kols, are subdivided into two or three hundred groups, each of which is called after an animal, a tree, or a plant; and the rule is that a member of a particular animal group, such as the snakes, the tortoises, the eels, or the mangooses, may not marry within that group. Thus a snake man may not marry a snake woman, but must select his bride from among the frogs, the tortoises, the mango-trees, or a host of groups which include the whole fauna and flora of the district. The paper attempts to account for this custom, which the late Mr. J. F. McLennan called *exogamy*, by connecting it with the theory of natural selection. Among other interesting facts the Bengal inquiry shows that the practice of infant marriage, and the custom forbidding widows to marry a second time, are greatly on the increase, and are being adopted by the lower castes as marks of social distinction. It is feared that the spread of infant marriage will have a weakening effect on the race, and will multiply and aggravate those special diseases of women which Lady Dufferin's Fund was instituted to deal with. The increase in the number of widows is in itself a great evil. It lowers the position of women in India, and tends to lower the standard of social morality.

PARIS.

Academy of Sciences, July 24.—M. Hermite in the chair.—M. Boussinesq presented the second and last volume of his "Course of Infinitesimal Analysis," and commented upon the application therein given of the integral calculus to physics and mechanics.—New researches on the relative stability of salts in the solid and dissolved state: aniline salts, by M. Berthelot. The author compares the heat of formation and the properties of the more stable aniline salts, such as the sulphate, nitrate, and chloride with the unstable ones, *e.g.* the acetate and benzoate. The observations furnish a new confirmation of thermo-chemical theories.—Heat of formation of certain amides, by MM. Berthelot and Fogh. The amides investigated are acetamide, propionamide, benzamide, and succinimide; and the experiments show that the heat of formation of anilides, *e.g.* acetanilide and benzanilide, is greater than that of the corresponding amides.—The share of the end-plates of motor nerves in the expenditure of the energy which produces contraction; influence exercised on the heating of a muscle by the number and nature of the changes of state which the end-plates excite in the contractile bundle, by M. A. Chauveau.—Discovery of a comet by M. Coggia at Marseilles Observatory. (See Our Astronomical Column.)—On the means of recognizing the *Cysticerci* (bladder worms) of *Tænia saginata*, which cause "measles" in the calf and ox, in spite of the rapid disappearance of the *Cysticerci* on exposure to the air, by M. A. Laboulbène.—On the sensibility of plants when regarded as ordinary reagents, by M. Georges Ville. The author has extended to peas and wheat his observations in 1867 on yeast as a test for phosphoric acid, and finds that their varying growth is an indication of extreme delicacy for very minute amounts.—On the production by electric discharges of images reproducing the principal characteristics of solar activity, by M. Ch. V. Zenger.—On the combination of observations, by M. R. Lipschitz. This is an extension of Gauss's application of the calculus of probabilities to errors of observation.—The diagrammometer: an additional apparatus for the study of curves, by Colonel Kozloff.—On the physical property of the surface of contact of two liquids under the influence of mutual affinity, by M. G. Van der Mensbrugghe.—On internal crystalline reflection, by M. Bernard Brunhes.—On the double elliptic refraction of quartz, by M. F. Beaulard.—On a magnetic anomaly observed in the neighbourhood of Paris, by M. Th. Moureaux. A discussion of the earliest results of a detailed magnetic survey of France now being made indicates that regions of local disturbance exist in the Paris basin.—Researches on the double phosphates of titanium, tin, and copper, by M. L. Ouvrard.—Researches on the optical dispersion of organic compounds: the ethers, by MM. Ph. Barbier and L. Roux.—Upon certain hydrates of the haloid esters, by M. Villard. The author finds that the iodide and fluoride of methyl form hydrates like the chloride and bromide. Experiments on the haloid compounds of ethyl show that the chloride and fluoride yield similar hydrates. The fluorides were gases prepared by M. Moissan's process, and yielded colourless crystalline hydrates.—On oxygluconic acid, by M. L. Boutroux. The author has obtained by the oxidation of either glucose or gluconic acid by bacterial action an acid, to which he gives the name oxygluconic, having the formula of glucoronic acid, $C_{12}H_{10}O_{14}$, but differing from the latter in being lævorotatory, very soluble in alcohol, and not yielding crystals on evaporation. The new acid appears to be identical with one recently obtained by M. Emile Fischer by the replacement of the acid radical of saccharic acid with an aldehyde group, using the action of sodium amalgam on its lactone.—On the examination of the impurities contained in alcohol, by M. Ed. Mohler.—On a new process for the determination of mineral matters in sugar by means of benzoic acid, by M. E. Boyer.—On the mineral springs of Cransac (Aveyron), by M. Ad. Carnot.—On the combinations of hæmoglobin with oxygen, by M. Christian Bohr.—Possibility of injections into the human trachea as a means of introducing medicines, by M. R. Botey.—Claim of priority in the discovery of craniectomy, by M. Guéniot.—On the mechanism of respiration in *Ampullaria*, by MM. Paul Fischer and E. L. Bouvier.—On the repair of the shell in *Anodon*, by M. Moynier de Villepoix. Numerous experiments on the growth in water with varying amounts of chalk in solution of the shell after artificial injuries indicate that it is a product of secretion of the mantle, that it is at first a purely organic formation, and that the lime for its consolidation is obtained from the surrounding medium.—On the secretion of silk in *Bombyx mori* (common silkworm), by M. Raphael Dubois.—The gangrene of the potato stem, a bacterial disease, by MM. Prillieux and G. Delacroix.—On the angle of polarization of igneous rocks and the chief lunar deductions therefrom, by M. J. J. Landerer. (See Our Astronomical Column.)

Berlin.

Physiological Society, June 18.—Prof. du Bois-Reymond, President, in the chair.—Dr. Blumenau gave an account of his researches on the development of the corpus callosum, carried out chiefly upon the brains of embryonic pigs, from which he concluded that the grey matter on the upper and lower sides of this structure grows by a fusion with the neighbouring bundles of arched fibres.—Prof. H. Virchow spoke on the gill-slits of the sturgeon, which he had examined with a view to finding a transitional form between the gills of Selachians and the osseous fishes. His anatomical and embryological investigations showed that with reference to its gills the sturgeon does not occupy that intermediate position which has been assigned to it by zoologists.—Prof. Gad described an experimental confirmation by Dr. Zagari of Donders's statement, denied by Knoll, that the inhaling of carbonic acid at the end of an expiration materially increases the depth of the ensuing inspiration. He had further found that this reflex effect is not observed after section of the vagi, and is not affected by section of the recurrent laryngeals. It did not take place when a glass tube was pushed down the trachea and one bronchus, so as to protect these portions of the air-passages from the action of the gas; but it reappeared on withdrawing the tube until its end rested at the bifurcation of the bronchi. From this it follows that the reflex inspiration is set up by the action of the gas on the mucous membrane of the bronchi. The effect was observed when the carbonic acid gas was diluted with 50 per cent. of air, but not upon further dilution. Marshall Hall's theory of respiration receives no confirmation from the above experiments. The concentrated CO_2 which makes its exit into the lungs themselves is probably inactive owing to its inevitable dilution by the residual air.

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