THURSDAY, OCTOBER 14, 1886

SCIENTIFIC WORTHIES

XXIV.—John Couch Adams

PROFESSOR J. C. ADAMS, whose portrait we this day present to our readers, entered St. John's College, Cambridge, in 1839. He soon gave promise of those great mathematical powers that have brought such renown to his University. He came out as Senior Wrangler in 1843, and the excellence of his answering is still a tradition at Cambridge.

By what seems to have been an inspiration of genius, he was guided after taking his degree to concentrate his talents on the solution of an astronomical problem of excessive interest but of corresponding difficulty. The planet Uranus had shown irregularities in its motion. The orbit differed from the elliptic path which an undisturbed planet would pursue, and the deviations could not be fully accounted for by the influences of the other known planets. The only explanation of the discrepancy which astronomers could be expected to favour lay in the supposition that there was some other still more remote planet yet unknown.

It was the search for this unknown planet which attracted the distinguished Senior Wrangler. We can imagine the delight with which a well-equipped mathematician would throw himself into the solution of such a problem. On it he was to concentrate the powers that had been cultivated during his University career.

The planet was to be sought for by the measured deviations of Uranus from its calculated positions. Those who have ever had occasion to study the planetary theory are well aware of the difficulty and the laborious intricacy of the subject. To most of us it has seemed a thorny and difficult problem when the planet is given to find the perturbations. What are we to say of the difficulty of the converse problem, Given the perturbations and find the planet! This was the problem which Adams faced, and which, to his imperishable fame, he succeeded in solving. The story of this discovery is familiar to all, and the controversies that arose have long since died away. To each of the joint discoverers, Leverrier and Adams, the gold medal of the Royal Astronomical Society was presented on February 11, 1848. In his address on the occasion, Sir John Herschel, speaking of the two astronomers, says:—

"M. Leverrier and Mr. Adams—names which as genius and destiny have joined them, I shall by no means put asunder; nor will they ever be pronounced apart so long as language shall celebrate the triumphs of Science in her sublimest walks. On the great discovery of Neptune, which may be said to have surpassed, by intelligible and legitimate means, the wildest pretensions of clairvoyance, it would now be quite superfluous for me to dilate. That glorious event and the steps which led to it, and the various lights in which it has been placed, are already familiar to every one having the least tincture of science. . . . I will only add that as there is not nor henceforth ever can be the slightest rivalry on the subject between these two illustrious men—as they have met as brothers, and as such will, I trust, ever regard each other—we have made, we could make, no distinction between them on this occasion. May they both long adorn and augment our science, and add to their own fame, already so high and so pure, by fresh achievements."

The discovery of Neptune was a brilliant inauguration of the astronomical career of Adams. We cannot here enter into a detailed account of his numerous labours. There is an admirable account given of them up to the year 1866 in the address of Mr. De la Rue to the Royal Astronomical Society, when Adams was again the recipient of a gold medal. We find that he has worked at and written upon the theory of the motions of Biela's comet; he made important corrections to the theory of Saturn; he made an elaborate investigation of the mass of Uranus, to which he was naturally attracted from its importance in the theory of Neptune; he has improved the methods of computing the orbits of double stars: but next to the discovery of Neptune the fame of Adams mainly rests on his researches on the moon and on the theory of the November meteors. To each of these subjects we must devote some attention.

In the *Phil. Trans.*, vol. cxliii. part iii. p. 397, his paper was published "on the secular variation of the moon's mean motion." This memoir originated a long controversy, in which the ablest mathematicians have participated.

The "secular acceleration of the moon's mean motion" is the phrase which denotes a gradual but excessively slow diminution in the moon's periodic time. Although the amount of this diminution is very minute, yet the fact that it always tended in the same direction rendered the amount accumulative, so as to become very perceptible in the succession of ages. The explanation of the acceleration formed a problem on which the great mathematicians at the close of the last century exercised their powers, and at length the explanation was given by Laplace. He found that, when the analytical expression for the moon's mean motion was developed, it contained certain terms depending upon the eccentricity of the earth's orbit. This eccentricity varies in consequence of the planetary perturbations, and hence the changes of the moon's mean motion. Laplace calculated the amount, and deduced, or thought he had deduced, a correspondence between the observed value and the calculated value. The high authority of Laplace, and the brilliant success of his efforts to explain other perturbations in our system, led to an acquiescence in his results, and the great problem of the secular acceleration was believed to have been solved.

In Mr. Adams's paper he joined issue with Laplace. The question was fortunately one which did not involve any real element of uncertainty. It was a problem in mathematics, or rather dynamics—difficult no doubt, but not really open to any ambiguity. Prof. Adams showed that Laplace had only considered a part of the disturbing influence, and when the true amount was determined, it came out to be only about one-half that found by Laplace. So serious a charge received the careful consideration which it merited. Several leading mathematicians impugned the calculations of Adams, but he was able to vindicate his theory at every point, and finally the correctness of his calculations was verified in one manner by M. Delaunay, and in another by Prof. Cayley. The importance of this result is not to be estimated merely by its value as a correction to Laplace. The author of the "Mécanique Céleste," like other writers, makes errors in his work. Numerous errors have been detected by Laplace's commentators, but the secular acceleration occupies quite a distinct position. It must be remembered that the calculations of Laplace appeared to render a physical explanation of a remarkable phenomenon. But when this calculation was shown to be seriously wrong, it followed that the cause of the secular acceleration conjectured by Laplace was inadequate to explain the observed facts. The labours of Adams thus reopened the breach between the observations and the theory. The variations in the eccentricity of the earth's orbit will account for part of the secular acceleration. The other part has to be accounted for in a different way. The theory of the tides seems to offer an explanation of the discrepancy. Owing to their incessant action the period of the diurnal rotation has been slightly elongated, and this effect, when duly taken account of, seems to remove the margin between the theoretical and observed values of the secular acceleration. This margin has indeed a singular interest in the recent theory of tidal evolution, inasmuch as it affords us the only measurable indication we have of the effect of tides on the earth's rotation.

The splendid shower of shooting-stars that occurred in November 1866 fixed the attention of astronomers on every part of the theory of these bodies. We were thus taught much concerning them, but for one of the most recondite parts of their theory we are indebted to the labours of Prof. Adams. It had been known that the great displays of the Leonids (for so these shooting-stars are called) take place every thirty-three years. From the year 902 down to the year 1866 many of the successive thirty-three-year periods witnessed the great shower, and records of a considerable number have been handed down to us.

These minute bodies must revolve around the sun, each pursuing its orbit in accordance with the laws of Kepler. It became of interest to find the size and shape of this orbit, as well as its position. Certain features of the orbit are readily determined. The recurrence of the shower on a particular day of the year gives one point in the path of the meteors. The direction of the radiant gives a tangent to that path, and therefore its plane. The sun, of course, lies at the focus, and only a single further element—the periodic time—is requisite to complete our knowledge of the orbit. We are indebted to Prof. H. Newton, of Yale, for his careful discussion of this subject. He had shown that the choice of possible orbits was limited to five. There was first the great oval orbit, in which we now know the meteors do revolve every 33¼ years. There was next a nearly circular orbit, with a periodic time a little more than a year; another similar orbit, in which the periodic time would be a few days short of a year; and there were also two other smaller orbits. Prof. Newton had also indicated a method by which it would be possible to discriminate the true orbit as one of these five. The mathematical difficulties of this method were no doubt great, but they did not baffle Prof. Adams.

In the *Monthly Notices* for April 1867, p. 247, will be found the paper in which he announced his solution of the problem. The orbit of the meteors is not fixed, but every time the great swarm comes round, the node is found to be 29' further on in the direction of motion. The effect of this is shown in the gradual alteration of the date of recurrence of the shower. The only influence known to us which could account for this change of the plane, is the attraction of the other planets. The problem, then, may be placed in this shape. A certain specific amount of change of the node takes place. The theoretical change can be computed for all the five different orbits, and Prof. Adams undertook to find it. The difficulty principally arises from the high eccentricities of some of the orbits, which rendered the more familiar methods of calculation inapplicable. After many months of labour, Prof. Adams, aided by his assistants in the Cambridge Observatory, completed his work. He showed that if the meteors revolved in the large orbit with the periodic time of 33¼ years, the perturbations of Jupiter would account for a change to the extent of 20'. The attraction of Saturn would augment this by 7', and Uranus would add 1', the effect of the earth and the other planets being insensible. The joint effect is thus 28', which may be regarded as practically coincident with the observed value determined by Prof. Newton. The great orbit was thus a possible path for the meteors, but to complete his discovery Adams had to show that neither of the other four orbits could experience the same perturbation. This, too, he succeeded in demonstrating: he showed that in no one of the other orbits could the change exceed 12'. Thus the orbit of the Leonids was discovered.

Those tremendous powers of calculation which have been exercised on the heavenly bodies with such signal results have also been occasionally applied in various other directions. The discoverer of Neptune has found relaxation from the labours of physical astronomy by little calculations on which we must gaze with astonishment. He has had the curiosity to compute the sums of the reciprocals of the first thousand numbers to 260 places of decimals. We have such confidence in the accuracy of Prof. Adams that we have not thought it necessary to repeat this calculation! He has also taken the trouble to calculate thirty-one of Bernouilli's numbers beyond the point that previous calculators had attained, and he has expressed each of them both as vulgar fractions and as decimals. The sixty-second Bernouilli, the last computed by Adams, runs to 111 places, where fortunately for astronomy the appearance of a recurring figure has terminated this inquiry.

Need it be added that on Prof. Adams every honour which science can bestow has been conferred. We have now the pleasure of enriching our list of Scientific Worthies by the addition of his portrait. R. S. B.

THE BRITISH MUSEUM BIRDS

Catalogue of the Birds in the British Museum. Vol. XI. Fringilliformes: Part II. Containing the Families *Cærebidæ*, *Tanagridæ*, and *Icteridæ*. By Philip Lutley Sclater. (London: Printed by order of the Trustees. 1886.)

DR. GÜNTHER and the authorities of the Natural History Department of the British Museum are to be congratulated, first, on having sought, and next on having secured, the services of Mr. Sclater for the execution of the eleventh volume of their "Catalogue of Birds." The principal group of which it treats is one that has been, for five-and-thirty years or more, the favourite subject of his study, and indeed there are people who hardly hesitate to assert that the final cause of the existence of the family *Tanagridæ* must have been to find occupation for that gentleman's ingenuity in discriminating, describing, and disposing its members.

In consequence of this the present volume of this "Catalogue" appears as a finished piece of work. Whatever may have been the faults of the plan on which the whole was designed, here its defects are reduced to a minimum, so that few are made manifest. The relationship of the *Cœrebidæ* to the *Tanagridæ* is outwardly pretty close, and there is as yet no indication that future research into their inward structure is likely to separate them more widely, though in the existing state of ornithotomical study it would not be safe to say more. Granting, then, as Mr. Sclater considers, that the former of these families is so nearly allied to the latter that "it is indeed somewhat difficult to separate them by external characters," the comprehension of these two groups in one and the same volume is a very natural proceeding. As regards the third family, *Icteridæ*, associated with them on the present occasion, opinions may reasonably differ. Mr. Sclater confesses himself open to doubt on this point; and, if he does so, a slight amount of agnosticism may be pardoned in others who know not one-half so much about them as he does. Possibly if he had referred to some remarks of Prof. Parker's (*Trans. Zool. Soc.*, x., pp. 266, 267) on the relations of this group, the matter might have seemed to him a little clearer. Mr. Sclater's belief is that, since these birds "present many points of alliance with" the *Sturnidæ*, *i.e.* the true Starlings of the Old World, it would therefore be better "to place them *after* the *Fringillidæ*." Now the multitude of "points of alliance" is perhaps rather apparent than real, and though Prof. Parker considers (*loc. cit.*) that the *Icteridæ* and *Sturnidæ* cannot be "considered to be unrelated," he also shows that the former have nearer allies in their own part of the world. But this by the way. It is more important to inquire in what sense the word "*after*" is used by Mr. Sclater in the passage just quoted. We may be sure that he does not entertain a notion of the possibility of deploying any part even of the animal kingdom in a straight line, as was of old time thought not only possible but expedient; for such a notion would be completely at variance with the doctrine of evolution, which he of course holds. If the word "after" is merely intended to refer to the purely arbitrary arrangement followed, or to be followed, in the "Catalogue," it signifies nothing, and we have no cause to complain. Again, if "after" is to be understood in the sense of "inferior to," then we should wholly agree with him. But if the procession of forms be contrariwise arranged—there being no evidence in this volume to show whether this is so or not—and by the word "after" a later and consequently higher or more specialised type be indicated, then we should, with all deference, beg leave to demur to the supposition. Whatever be the rank and proper place among the true *Passeres* of the *Fringillidæ*—and Dr. Stejneger has lately propounded the view that theirs is the highest—the fact should always be remembered that the so-called *Fringillidæ* of many systematists certainly contain at least two groups, which in their more advanced stages can, so Prof. Parker tells us, be always discriminated. These two groups are the Finches proper and the Buntings, which last several taxonomers have recognised as forming a family, *Emberizidæ*, equal in value to the restricted *Fringillidæ*. Now Prof. Parker has shown that it is to the *Emberizidæ* rather than to these *Fringillidæ* that the *Icteridæ* are allied, and it therefore becomes important to determine the limits of the *Emberizidæ*, which, owing to the want of anatomical or morphological research, is admittedly hitherto a matter of guesswork. In regard to those members of the former which belong to the Old World, or are common to it and to the New World, no difficulty has as yet presented itself. It is in the New World alone that the doubtful forms exist; but even of some genera peculiarly American—*Phrygilus*, for example, as proved by Prof. Parker—indication is not wanting; and if we might hazard a supposition on the subject, it would seem on several grounds more likely that a closer alliance should be shown to exist between the *Icteridæ* and the *Emberizidæ* than between the latter and the true *Fringillidæ*.

From what has been submitted in the foregoing sentences, those who can "read between the lines" may perceive that underneath the points just touched upon is a question of much greater significance than is ordinarily presented by matters of mere taxonomy—especially of the taxonomy of a group of birds so homogeneous as are the *Passeres*. It is undeniable that the American forms of this multitudinous and confessedly highest group of birds (with the exception of those which, being so closely related to the Old-World forms may be not unreasonably supposed to be their derivatives) show a great preponderance of the weaker and, morphologically speaking, lower types. It is in the New World, and especially in South America, that we find all the *Tracheophonæ* and a majority of the different groups of *Oligomyodi*.[1] We can hardly doubt that these are as nearly autochthonous as any groups which now exist; that is to say, they had their origin on land which is now represented by the American continent. Though analogy is often a deceitful guide, it does not seem irrational to urge the same of the *Oscines*. Among them it is certain that not one of the three families which different systematists have selected for the post of leader is strongly represented in the New World—two of them, the *Corvidæ* and *Fringillidæ* (if we exclude the presumed *Emberizidæ*), very poorly indeed; while the remaining family, *Turdidæ*, cannot number, even at a very high estimate, one-third of its members as American. The meaning of these considerations will become plainer if we substitute for the expression "weaker and lower types" its justifiably equivalent rendering, that of "older and more generalised types." Then we shall see the important signification of the alliance we have supposed to exist between the *Icteridæ* and the *Emberizidæ*; and, moreover, a reasonable means of accounting for the remoter relationship, recognised by Mr. Sclater (Introd., p. viii.), between the *Tanagridæ* and the *Fringillidæ* on the one hand, and the *Cœrebidæ* and *Mniotiltidæ* on the other, is provided. This result, we trust, will serve to excuse these remarks, which might otherwise appear to be irrelevant; and, speculative as

[1] To attempt here to account for the distribution of the non-American families of this group—*Pittidæ*, *Philepittidæ*, *Eurylæmidæ*, and *Acanthisittidæ*—would lead us far beyond the limits of our present subject.

they are, it must not for a moment be imagined that we think the introduction of anything like them was needed or would have been expedient in such a volume as that now under notice. A reviewer may take liberties that are denied to an author.

But now to return to our proper business. In his treatment of the subject Mr. Sclater, as might be expected, shows himself its master; not but that there are a few points—and one of them we have indicated—on which he owns himself doubtful. This is no drawback, for such there are, and long will be, in every matter of this kind. One great merit, in our eyes at least, is that he steadily treads the old high-road which has conducted its passengers to so many great achievements, and refuses to follow the bewildering by-paths, of late so much vaunted by various writers, that are eventually found to mislead the unwary or inexpert traveller into bottomless bogs. A plain view of things is taken, and one that is suggested no less by eminent knowledge than by common-sense. There is no attempt to regenerate a fallen world of science within the narrow limits of a catalogue, or to make the catalogue of a single museum, however great its wealth, pass for a monograph. From the beginning of the volume to its end there does not appear the trace of a wish to indulge—may we be pardoned the word?—a "fad"; not even in the frivolous matter of nomenclature, a rock on which all novices are sure to strike, and often to split.[1] The various "keys" with which every group is provided seem always to fit and to turn easily in their locks—not, indeed, a surprising fact, since Mr. Sclater, if not the inventor, has long been one of the most skilful handlers of this convenient differentiating instrument, so useful when manufactured by an adept, and so useless when turned out by a tiro, who not seldom contrives, in the course of a few lines, so to complicate his conditions (of his own choosing, be it remembered) as to render them characterless, if not contradictory. To sum up, it may be said that, supposing the plan of the British Museum "Catalogue of Birds" to have been well laid, Mr. Sclater has shown how it may be well executed.

THE VITAL STATISTICS OF GLASGOW

The Vital Statistics of the City of Glasgow. Part II. The Districts of Glasgow. By James B. Russell, M.D., LL.D., Medical Officer of Health.

IN this Report Dr. Russell presents us with the vital statistics of the city of Glasgow and its districts for 1880, 1881, and 1882, and with some comments on, and inferences to be drawn from, the facts enumerated. Some years ago an Improvement Trust scheme for the sanitary reformation of the houses of the people was elaborated and put into operation. This scheme has achieved "a summary revolution in the worst parts of the city," not apparently before it was wanted, for Dr. Russell shows that some of the districts of Glasgow—notably that known as Bridgegate and Wynds—do not compare favourably even with the worst slums of London or Liverpool. Bridgegate and Wynds had a death-rate for 1880, 1881, and 1882, of 38·3 per thousand, a birth-rate of 37·1 per 1000, a death-rate under one year per 1000 born of 206, and a death-rate from consumption and acute diseases of the lungs of 16·75—this figure alone being higher even than the total death-rate of many English towns. Much of this district has been improved off the face of the earth—the population in 1881 was 7798, in 1871 14,294—still the houses that are left "are radically bad, and total demolition and destruction is the only remedy." It is such districts as these that have, as Dr. Russell remarks, "been the heartbreak of successive generations of Glasgow philanthropists." The death-rate of the city of Glasgow, as a whole, for 1880, 1881, and 1882, was 25·2 per 1000, with a birth-rate of 37·3 per 1000; although considerably less healthy than London, Glasgow compares favourably with Dublin, and stands on about the same level as Liverpool and Manchester. The death-rates of the different districts of the city in 1871–72—prior to the improvement schemes—are compared with those in 1880, 1881, and 1882, subsequent to the carrying out of many improvements in unhealthy areas by demolition and reconstruction. The comparison shows that in all the districts the general death-rate and the death-rate under five years (with one exception) were much lower in the latter period than in the former. "This result," Dr. Russell remarks, "is important, as proving that the displacement of the inhabitants of the central parts of the city has not deteriorated the health of the districts into which they have removed. It was proved by special investigation that the people whose wretched houses were demolished by the Improvement Trust distributed themselves over the city. It is often said that the habits of these people are such that, go where they please, they will not be the better of the change. It is evident, however, that they found physical conditions so much more conducive to health that, whether or not their habits have been improved, undoubtedly their health has been, in their new residences. The moral is to persevere in the destruction or improvement of the houses of the people. The certain result is to improve their health."

The influence of overcrowding on mortality, and the connection subsisting between overcrowding and an Irish population are well shown in the contrast between two of the districts. Blythswood is remarkable as having the lowest proportion of inmates per inhabited room, the largest proportion of large-sized houses, the lowest death-rate, the lowest birth-rate, the lowest mortality under five years, the lowest proportion of deaths under one year per 1000 born, and the lowest proportion of Irish-born of any district in Glasgow. Bridgegate and Wynds, on the other hand, has the largest proportion of inmates per inhabited room, the largest proportion, save one, of one-apartment houses, the highest death-rate over all, the highest death-rate under five years, the largest proportion of deaths under one year per 1000 born, and the highest percentage of Irish-born inhabitants. And in general, Dr. Russell states it to be a fact "that a district which has houses occupied *above* the standard number of persons per room (*i.e.* above the mean number of the whole

[1] Indeed, we think we should have ground for complaining that Mr. Sclater has not made one nomenclatural change. He is of course as well aware as any one that the idea of a generic type never occurred to Linnæus, though it was ever present with Brisson. Nevertheless, modern specialists are required to find a type for every Linnæan genus; and, despite the almost universal practice, the type of *Tanagra* (which is only Brisson's *Tangara* with a modified spelling) is clearly *T. tatao*. Moreover, the generic term *Calliste*, used by Mr. Sclater for that species and its congeners, is but questionably admissible from its prior application by Poli ("Test. utr. Siciliæ," i. p. 30)—in a different dialectical form (*Callista*), it is true; but the Goddess of Wisdom may be called to witness that her name, whether written Athen*e* or Athen*a*, is one and the same; while we ask her pardon and that of our readers for drawing attention to such a trifle.

city), has a general death-rate *above* the standard death-rate of the city, an infantile death-rate *above* the standard infantile death-rate of the city, and especially that the fatality of those diseases which are directly related to overcrowding or deficiency of breathing-space—viz. diseases of the lungs and infectious diseases—is in excess in those districts."

Dr. Russell also discusses such subjects as the percentage of uncertified deaths, and the insurance of lives in friendly societies, the relations of legitimacy and illegitimacy to certification and insurance, and their bearings on the social conditions of poor populations—subjects of great interest to philanthropists and sanitary reformers, as indicating the instincts and habits of so large a mass of our poor populations. The rest of Dr. Russell's Report is of more purely local interest; but enough has been said to show that Glasgow, if it has been in want of sanitary reform, has not been behindhand in what may be described as one of the greatest works of the age, and that philanthropy in this case has met with its due reward in the vast improvements effected in the social condition of the people.

THE FRESH-WATER FISHES OF EUROPE

The Fresh-Water Fishes of Europe. A History of their Genera, Species, Structure, Habits, and Distribution. By H. G. Seeley, F.R.S., &c. With 214 Illustrations. 8vo. Pp. vi. and 444. (London, Paris, New York, and Melbourne: Cassell and Co., 1886.)

A WORK containing an original, exhaustive, and critical account of the fresh-water fishes of Europe, such as might bear the title heading this notice, would be an undertaking which would require on the part of the author a thorough acquaintance with ichthyology, considerable experience with the method of ichthyological research, an autoptical examination of many of the types preserved in the various European museums, and, finally, the formation of a collection more complete than the combined series of European fresh-water fishes in the museums of London, Paris, Vienna, Berlin, and St. Petersburg; in fact, an undertaking that would occupy the greater portion of a life-time, and stand as a monument of which any naturalist might be proud.

We have too high an opinion of Prof. Seeley's abilities to doubt for a moment that he might have produced a standard work of this nature, if he had chosen to devote the requisite time and labour to it. But what he has really accomplished is merely a compilation from the standard works mentioned in his preface, without the addition of any new facts or observations, and without any attempt at such a critical treatment of the subject as might be expected from an author acquainted with the objects described. His book, in fact, might have been compiled in the author's own library or in that of the British Museum without his looking at a single fish. The illustrations are no less wanting in originality; with the exception of half-a-dozen anatomical figures familiar to every ichthyologist, the remaining 208 are simply borrowed from Heckel and Kner, "Süsswasserfische der östreichischen Monarchie"; and consequently no fish peculiar to any other part of Europe or absent from the Austrian fauna is represented in the book. It should be remembered, however, that at the date of their publication (1858) the two Austrian ichthyologists above named were enabled to include in their fish-fauna a number of the species of Northern Italy. We think that the source whence the illustrations were taken should have been stated in the preface.

As regards the usefulness of the book, there cannot be any doubt that a handy book on the fresh-water fishes of Europe was a great desideratum. A glance at the natural-history columns of the *Field*, *Land and Water*, and other weekly papers shows the great number of travellers on the Continent who seek for information about fresh-water fishes which are strange to them, and to whom the original works wherein they could find it are either unknown or unintelligible. For this large class of the non-scientific public Prof. Seeley has supplied a real want and a useful book of reference, the utility of which would have been much greater could he have induced his publishers to go to the expense of figuring other fishes besides those found in Austria; and we cordially join him in the hope "that the fabric of the work will give a new interest to the fishes of our own country, and may influence British peoples to a thrifty cultivation of the roving wealth which swims, little heeded, in our forms of fresh-water fish life."

OUR BOOK SHELF

Papers in Inorganic Chemistry. Part I. Non-Metals. Part II. Non-Metals and Metals. By George E. R. Ellis, F.C.S. (London: Rivingtons, 1886.)

THIS is a collection of examination questions arranged progressively, and is intended for the use of science teachers and students. The idea is a good one, and we have no hesitation in saying that the book will be appreciated by those for whose benefit it has been compiled. Although we are far from approving of the present mania for examinations, we agree with the author that the conscientious answering of well-selected questions is of great advantage to the student. It not only tests his knowledge gained from text-books and from lectures, but it renders it more accurate and permanent.

The solution of chemical problems is generally a weak point with beginners, and we are glad to see a fair proportion of such problems in Mr. Ellis's book. There are, however, a few arithmetical questions which appear a little out of place in papers in inorganic chemistry. On p. 6, for instance, there is one on the tonnage of the s.s. *Oregon*, and others may be found on pp. 10, 12, 30, &c.

LETTERS TO THE EDITOR

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

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

Our Guns

YOUR article on the above (p. 517) induces me to repeat an appeal which I made ten years ago in a paper on "Explosive Compounds," contributed to Stanford's "British Manufacturing Industries." I there pointed out the enormous discrepancy between the results obtained in the testing of the pressure exerted by the explosion of gunpowder by the Government Committee on Explosives and those of Count Rumford made in 1793, and described in his essay on "The Force of

Fired Gunpowder" (published in London, 1802, and recently reprinted, with his other essays, in America).

Our Government official experiments give a pressure per square inch varying from 15·4 to 28·1 tons per square inch, the latter obtained in the 81-ton gun. Rumford's maximum was 277 tons, as shown by overcoming the tested tenacity of metal that the powder tore asunder; or 73 tons, as indicated by the lifting of a weight by the explosive energy.

As I explained in the paper above named, the tearing test is fallacious as a theoretical measure of the force exerted, because the tenacity of the metal was tested by Rumford, as it still is by others, in most cases, by a gradually-applied strain, which should not be compared with a vibratory shock. As a measure of the practical bursting possibilities of gunpowder upon metal of given thickness and tenacity, as usually measured, Rumford's figures are directly applicable, though allowance must be made for the relief afforded by the movement of the shot in a gun.

My appeal was for a repetition of Rumford's experiments by those who are responsible to the nation for these very serious matters, and for a reconsideration of the reliability of the method of testing by the "Rodman" and "Crusher" gauges, which have supplied such very different results from those of Rumford. My reasons for believing Rumford's experiments to be more reliable than those of the Committee were stated as follows, and I still maintain their cogency:—

"(1) The resistance to be overcome, and by which the force was measured, viz. the gravitation of a known weight, was by far more definite and measurable than the degree of indentation or compression of a cylinder of copper, which serves as the measure of force in the Rodman and Crusher gauges.

"(2) In Rumford's arrangement the force of the explosion was more directly applied to the resistance by which it was measured than in the official experiments, where the shock of the explosion was first communicated to a solid piston 1 inch in length, and by this transferred to the copper cylinder of the Crusher gauge or the knife of the Rodman gauge. By this arrangement much of the force is expended upon internal work in the intervening piston, producing mechanical vibration of its substance, and a returning wave of elastic compression, which would have no measurable effect on the gauge. Besides this, another portion of the force compressing the piston must be converted from mechanical motion into heat motion.

"If any reader supposes that I am hypercritical in making this objection, let him try the following experiment. Take a block of iron—a common 1 lb. weight, for example—place it on the hand, and the hand upon a table; then strike the weight smartly with a carpenter's hammer. It will be found that blows which would fearfully mutilate the hand if directly applied to it, may be struck upon the weight thus resting entirely upon the hand, and will scarcely be felt, provided the blows are dealt suddenly and smartly. The mountebank's exploit of breaking a great stone upon a man's bare breast, the common method of reducing the dimensions of geological specimens by holding them in the hand and cracking with a hammer, and the experiment of shooting a bullet through a swinging door without moving it on its hinges, are familiar illustrations of this principle, which appears to have been overlooked in these official researches.

"The complete absence of windage in Rumford's arrangement, by exploding in a perfectly closed chamber, is a third advantage. I therefore regard Rumford's experiments as the best that have yet been made on this interesting subject, although, as he himself admits, they are by no means free from error."

W. MATTIEU WILLIAMS

Photographs of Stellar Spectra

THE article upon this subject in NATURE, vol. xxxiv. p. 439, requires a correction which has been pointed out by Dr. Copeland. The spectrum of the star DM. + 37° 3821 was observed by him on September 22, 1884, and found to contain bright lines; the observation was published in the *Monthly Notices* for December 1884, but was overlooked at the time when the article above mentioned was prepared.

A similar correction, pointed out by Dr. Huggins, is required in the "Investigation in Stellar Photography" by the present writer, published in vol. xi. of the "Memoirs of the American Academy of Arts and Sciences." On p. 208 the method of observing stellar spectra by means of a prism placed before the object-glass of a telescope is ascribed to Secchi. In fact, it had previously been employed by Fraunhofer.

EDWARD C. PICKERING

The Late American Earthquake and its Limits

IN your very flattering *critique* of my "Alphabetical Catalogue of European Earthquakes" the reviewer says:—"The tendency to alignment in volcanoes has often been noticed; Prof. O'Reilly indicates a similar peculiarity in earthquakes, adding that the lines along which they range approximate to great circles. This inference or suspicion can be verified only by detailed charting." Judging from the facts published up to the present relative to recent earthquakes of America and Europe, I think some such verification has been furnished by them. At the Exhibition of Scientific Apparatus held at South Kensington in 1877, I exhibited a globe mounted so as to allow of great circles being easily traced through points on the surface. Several coast-line great circles were shown thereon, amongst them that of the southern boundary of the Tertiary formation in the United States. It was also marked on the sketch earthquake-map of Europe exhibited before the Section of Geology of the British Association at their Swansea meeting of 1882, and on other maps, such as the earthquake map of the British Islands; and yet no leading fact went to prove that any particular significance should be attached to this great circle. The earthquakes of August 27 and 28 in the United States have furnished, in my opinion, some proofs of this significance. The following are the places through which this great circle passes:—Victoria Fort, on coast of Gulf of Mexico; Cairo (Ill.); axis of Lake Erie; Lake Ontario; River St. Lawrence (parallel to); New Brunswick coast of River St. Lawrence; Labrador, south coast; York Point and Straits of Belle Isle; Ireland, Shannon mouth; Wales, south coast of; St. Bride's Bay; Mendip Hills; Southampton; Dieppe, north of; Chalons; Bâsle, north-east coast of Zurich Lake; Coire; Trent; Venice; Dalmatian coast; south-west coast of Isola Longa; Mount Olympus; Skyro Island; Syrian coast, head of Akaba Gulf; Arabia, Mount Seiban, Wady Maifa; Cape Guardafui; Pacific Ocean, Paumota Group; coast of Mexico, near Cape Corrientes; Zacatecas territory.

According to Major Powell's telegram, the origin of the earthquake was along a line of post-Quaternary dislocations on the eastern flank of the Appalachian Chain, especially where it crosses North Carolina. The great circle just described passes more inland than that mentioned by Major Powell, and was taken, as regards position, from the geological map of the United States, by C. H. Hitchcock and W. P. Blake, 1873, but it is parallel to the line limiting the Tertiary formation which crosses North Carolina, and which is probably also the seat of the post-Quaternary disturbance referred to. The great circle in question traverses the area of disturbance between Kennett (Ark.) and Buffalo (on Lake Erie). On the European side the following places lie near its direction. The Bristol coal-fields, where an explosion of fire-damp took place lately, about the time of the earthquake; the English Channel, lat. N. 50° 10′ and long. W. 1° 40′, where an earthquake shock is reported to have occurred by H. Mohn in your issue of September 23 (p. 496); the point lying about fifty-five miles to the south of the great circle, where it passes at Southampton. Switzerland: M. Forel reports in your journal of the 16th ult. (p. 469) a series of shocks in the western part of Switzerland having occurred in the first days of September, and which he considers as the *suite* of the earthquake of August 27. In Eastern Europe an earthquake occurred on this same date, which travelled eastward from Malta to the South of Italy and reached Smyrna, which lies somewhat to the north of the great circle. In Mexico an earthquake is reported as having occurred at Tequisextlan on the 3rd ult. I can find no such place, but if it be the same as Tepantitlan, about fifty miles east-north-east of Guadalajara, it would be somewhat south of the great circle in question. As all these places are not far removed from the direction of the great circle, and as there must be several parallel lines of fissuring in the Appalachian Chain, thus forming a zone, there is in this way, I think, evidence furnished that a zone of seismic action exists, having the general direction of the great circle represented by the continuation of the boundary-line of the Tertiary formation in the United States to the west of the Mississippi Valley, as marked on the geological map of Messrs. Hitchcock and Blake.

In the map forwarded herewith I have defined the surface of disturbance by lines joining the extreme points mentioned as having suffered shocks; but further information may, and probably will, modify this outline. The polygonal form thus obtained is, I think, more satisfactory than the curved forms usually adopted, since there are some grounds for thinking that the limits of disturbance are generally lines of faulting or limits of formations. In the first report received, the extreme points mentioned to the west were Jacksonville and Chicago, both situated on a line which represents the axis of the promontory of Florida, as shown by the map. The great mass of the surface shaken lies to the east of this line, so that this surface would be bounded by coast-line directions, at least partially. When fuller information comes to hand, I trust to be able to show more perfect results in this respect.

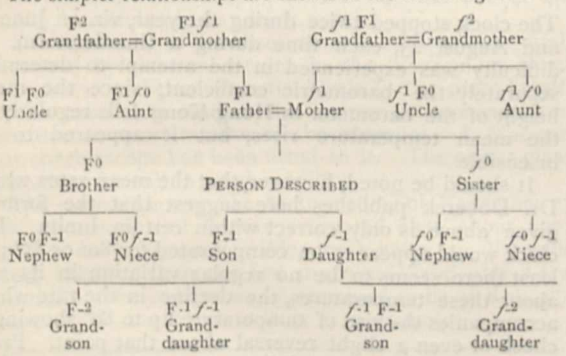
J. P. O'REILLY

Algebraic Notation of Kinship

MR. F. GALTON has described two systems of kinship notation: one in his work on "Hereditary Genius," pp. 50-53; the other in a letter to NATURE, vol. xxviii. p. 435. I propose to indicate here the outline of another system, which, though slightly more cumbrous in form than Mr. Galton's, seems to me to possess some advantages of its own.

Let us denote the male members of a family by a capital letter, say F, females by a small letter, *f*. Taking the person described as a starting-point, relatives in different generations may be denoted by *indices* attached to these letters. For relatives in the same generation, the index is 0; for those in the first, second, &c., generation before him, the indices are 1, 2, &c.; for those in generations following him they are -1, -2, &c. Thus, a brother would be denoted by the symbol F^0, a sister by f^0; the father by F^1 and mother by f^1; a son by F^{-1} and a daughter by f^{-1}. Again, the father's father would be denoted by $F^1 F^1$, or more shortly by F^2; the father's mother by $F^1 f^1$; a son's son by F^{-2}, a daughter's son by $f^{-1} F^{-1}$; the father's brother by $F^1 F^0$ (or perhaps by F^{10}, if it be remembered that here 10 stands for 1 + 0, and not for ten, which is too large a number to be often required); the mother's brother by $f^1 F^0$; the father's sister's son by $F^1 f^0 F^{-1}$, and her daughter by $F^1 f^0 f^{-1}$; and so on. The advantages of the system are: (1) that it is readily used and interpreted; (2) that the generation of any relation with respect to the person described may be found at once by adding the indices of his kinship symbol. For example, in the last two instances given, the sum of the indices is 0, showing that in both cases the generation is the same as that of the person described.

The simpler relationships are shown in the following table:—



If desired, suffixes to the letters might be added to denote the position in his family of any person noted in the kinship symbol. The symbol $F_3^{-1} f_5^{-1}$ would, for example, denote a son's daughter, the son being the third member of his family, and his daughter the fifth.

CHARLES DAVISON

Birmingham, September 30

Physiological Selection

AS Dr. Romanes has had his attention drawn to my letter (NATURE, vol. xxxi. p. 4), he may be interested in knowing just how far his theory of physiological selection was anticipated by what was in my mind.

My idea was that a spontaneous variation might occur in the sexual elements of the offspring of one parent or pair which would leave them fertile with each other, while rendering them almost or quite infertile with the rest of the species, so that the family would be physiologically insular.

Though I did not definitely so limit it, it did not seem to me likely that a corresponding change in both sexes, which was what I had in my mind, would occur, except in the offspring of the same parent or pair; and I rejected the idea of a gradually increasing infertility in favour of a total or nearly total infertility arising in the one generation, because I did not see any cause for the continuous increase from generation to generation of such infertility.

It did not occur to me that a partial infertility would, in a number of generations, produce the same result, as pointed out by Dr. Romanes (NATURE, August 5, p. 316). Nor do I now see clearly that it would ever lead to the total infertility which exists between species which have not otherwise diverged very much. At present, however, I only wish to point out that the idea of gradually increasing infertility was in no way anticipated by me.

EDMUND CATCHPOOL

Friends' Institute, 13, Bishopsgate Street Without,
London, E.C., October 9

American Vines

IN reading Prof. Carruthers' very interesting address to the Biological Section of the British Association, I observe that he says, when speaking of the vine discovered by Dr. Schweinfurth at Abd-el-Qurna: "The leaves which have been obtained entire exactly agree in form with those cultivated at the present day, but the under-surface is clothed with white hairs, a peculiarity which Dr. Schweinfurth has not observed in any Egyptian vines of our time." Will you allow me to remark that this is a character of several of our American vines? Both the Northern Fox and the Summer Grape (*V. Labrusca* and *V. æstivalis*) are conspicuously downy on the lower surface of the leaves—so much so that they appear white.

This fact adds another to the list of points in which the old flora of the eastern hemisphere resembles that now existing on the western side of the Atlantic. But the resemblance in this case is of much more recent date than those with which we are so familiar from the researches of Prof. Heer among the Oeningen beds of Switzerland.

In connection with the facts above mentioned, it would be of interest to ascertain if an opportunity should ever occur whether the other noteworthy differences between the American vines generally and the European vine, namely, the musky or foxy flavour and the soft and pulpy, not firm and fleshy, berry were accompaniments of the downy leaf. This may never be possible, but it would serve to show which of the two was the older stem from which the other has diverged.

E. W. CLAYPOLE

Akron, O., U.S., September 30

"Scopelus mülleri"

A FEW weeks since I received a letter from Mr. Southwell, of Norwich, wherein he informed me that Capt. Gray had sent him a very interesting fish, which he kindly forwarded to Cheltenham. He captured it on August 1, 1886, in lat. 73° 12′ N., and long. 14° 28′ W. Capt. Gray remarked:—"It was at the surface; I noticed it while away in a boat as I leant over the bow and watched the water as it passed. It was covered with bright golden scales when I first found it, but they are nearly all rubbed off. It was alive when I picked it up, and the temperature of the water was 35° F., and that of the air 35° also."

The specimen is in comparatively a good state of preservation; the tail, however, has been broken, reducing its total length to 2 inches; from the snout to the base of the caudal fin, 1·8 inch.

D. 14, P. 11, V. 8, A. 16, C. 19, L.l. 36.

Its proportions are normal, agreeing with Collett's description, the origin of the dorsal fin commencing exactly midway between the end of the snout and the base of the caudal fin. As good examples appear to be very rare, I propose remarking on certain appearances which have been in dispute. The eye-like spots are thus disposed: along the edge of the abdomen, between the throat and base of the ventral fins, 5 pairs; between the ventral and anal, 3 pairs; along the base of the anal, 8 pairs; beyond the anal, 6 pairs. Krüger gave a similar number between the ventral and anal to what exists in this specimen, but Collett found 4 pairs there. Between the 6th and 7th pairs along the base of the anal fin, and between the 5th and 6th pairs behind that fin, there is a wider space than between the others. Along the side and below the posterior half of the lateral line are two more of these eye-like spots, while a row of three passes from the anterior of these to the subopercle. Another spot exists at the shoulder above the gill-opening, and an indistinct one on the edge of the preopercle.

The figure in the magnificent work of the "Fishery Industries of the United States," plate 202, agrees with this specimen in the proportions of the body and length of the fin-rays; but, supposing the species to be the same, differs from it materially in some other points. The position of the dorsal fin is shown too far forward; the scaling is not identical, as the lateral line in Capt. Gray's specimen stands upon a narrow but vertically elongated row of smooth scales, having three rows of smaller ones above it, and four below it; also the eye-like spots are not similarly placed, and the pectoral fin is narrower, with its rays more elongated. FRANCIS DAY

Cheltenham, October 1

The Sense of Smell

WITH reference to Mr. Mitchell's inquiries (NATURE, September 30, p. 521), there is a peculiarity about musk which I have never found anybody to be previously aware of, namely, it is impossible to smell it *twice*, taking two good "sniffs" consecutively at a plant, *i.e.* after a single exspiration; on the second inspiration there is no odour of musk whatever.

GEORGE HENSLOW

Humming in the Air caused by Insects

YOUR correspondent who writes on the above subject in this week's number of NATURE (p. 547) remarks that "It is singular that no explanation has been offered by any one for such a common phenomenon." May I be allowed to refer him to my "Observations in Natural History" (published in 1846), p. 226, where I have given a statement of my own on the subject, adding a reference to Humboldt's "Personal Narrative," in which he makes some remarks on this humming, as heard in the tropical regions, where the phenomena is naturally so much more striking, and on a wider scale.

There can be no doubt the explanation of the phenomenon given by your correspondent is the correct one.

Bath, October 9 LEONARD BLOMEFIELD

THE HONG KONG OBSERVATORY

DR. W. DOBERCK, Government Astronomer at the above Observatory, has recently published an official report on the astronomical instruments under his charge, and on the time service of Hong Kong in 1885, the determination of local time being the chief purpose of the astronomical branch of the institution.

The Report states that the Observatory possesses a transit instrument, by Messrs. Troughton and Simms, of 3 inches aperture and 3 feet focal length. Setting in declination is effected by means of two small circles fixed on the telescope near the eye-end, and read by levels. The axis is perforated for side lamps. The pivots, which are made of chilled bell-metal, show no perceptible difference between their diameters, but minute irregularities appear to exist, though too small to allow their exact amount to be determined by means of the axis level This level is used in determining the inclination of the axis, and another similar level is provided for use with the zenith micrometer in the observation of differences of zenith distances on either side of the zenith.

The eyepiece was originally furnished with one movable and seven fixed vertical wires, but the latter after a little while began to get entangled with the fixed wires, and finally broke. Although it had been found very useful in the determination of the instrumental constants, it was not thought well to replace it for fear lest the permanent wires might become disturbed or broken by it. Transits were at first observed over all the seven wires, but in 1886 only the five middle wires have been used. There are also two horizontal wires about a minute of arc apart, and the object the transit of which is to be observed, is brought midway between them. The eyepiece and wire system can be revolved through a quarter of a revolution, so that the vertical wires become horizontal, and can be used for determining the differences of zenith distance for latitude; but as the instrument is in constant use as a transit, this arrangement has never been made use of, there being the less necessity for employing it, as Col. Palmer had accurately determined the latitude of the Observatory in 1882.

The telescope rests upon a cast-iron stand with reversing apparatus; no change in the inclination has ever been perceived to be caused by the reversion. The stand rests on a slab of Portland stone on the top of a brick pier sunk 5 feet in the ground, where it is surrounded by a brick cylinder to protect it from surface oscillations.

In 1884 505 transits were observed; in 1885, 313; the inclination of the axis was observed 150 times in the former and 117 in the latter year. A meridian mark, which is viewed through an object-glass of about 66 feet focal length is placed about 70 feet to the north of the transit instrument; another meridian mark is 11,354 feet to the south across the harbour.

The standard sidereal and mean time clocks were supplied by Messrs. E. Dent and Co. The former has a cast-iron back which is firmly screwed to iron bolts cemented in the pier placed in the clock-room. The pendulum has the zinc and steel compensations originally designed for the transit of Venus expeditions. The clock was also supplied with a galvanic contact apparatus omitting one second each minute, for working a sympathetic dial in the transit-room, but as the contact-apparatus was found to interfere with the going of the standard-clock, its use was discontinued early in 1885, and the observations have since been made with a chronometer which is subsequently compared with the standard-clock.

The mean daily rates during ten-day periods of the standard clock are given in a table, and from the rates between January 1 and June 9 the following formula for the rate at t degrees Fahrenheit is deduced:—

$$r = + 1s.{\cdot}247 - 0s.{\cdot}033\ (t - 70^\circ).$$

The clock stopped twice during the year, viz. on June 12 and August 23, each time during a thunderstorm. A difficulty was experienced in the attempt to determine separately the barometric coefficient, since the mean height of the barometer in Hong Kong falls regularly as the mean temperature rises, but it appeared to be insensible.

It should be noted, however, that the mean rates which Dr. Doberck publishes here suggest that the formula given above is only correct within certain limits. The clock would appear to be compensated for 80° or 85°; at least there seems to be no regular variation in its rate about these temperatures, the decline in the rate which accompanies the rise of temperature up to 80° showing a check or even a slight reversal about that point. Probably, however, the mean daily rates cannot be trusted to the degree of refinement to which they are here given. The number of transits observed is decidedly small, and the errors of the transit-instrument do not seem to have been very frequently or regularly determined during 1885. No information is given as to the degree of accordance of the daily rates actually observed.

The mean time clock is similar to the sidereal standard clock, and appears to go as well. It is furnished with galvanic contact springs, which are pressed every hour at the exact second, and send a current through a reversing commutator worked by one Léclanché cell, by means of which the current that drops the time ball at 1 p.m. is closed.

Some trouble has been experienced with the time ball. First the galvanic coil in the mean-time clock-case for setting the clock right before the ball is dropped, is not strong enough, as it takes nearly an hour and a half to correct an error of a second. The lock sent out with the time ball, also, was not fit to drop the ball, the blow of the hammer failing to discharge the bolt, so that the hammer had also to be struck at the instant the current arrived from the clock. The coil was fused by lightning on June 12, and from that date until November 20, the ball was dropped by hand. Since November 22 a new lock has been fitted, which gives satisfaction.

The time-ball tower is erected on Tsim-sha-tsui Point, directly facing the shipping. It stands in front of the new police-station beside the mast for hoisting meteorological signals, at the foot of which the typhoon gun, pointed towards the city opposite, is placed. In the police boat-basin, at a short distance north-west of the tower, the small observatory is built. The time-ball tower is about half a mile distant from the observatory, with which it is connected by wire. The base of the tower is about 40 feet above sea-level, and the top of the ball-mast about 84 feet. On the ground-floor is a massive granite pier, which supports the entire apparatus. Dr. Doberck describes at considerable length the arrangements for dropping the ball, for breaking its fall, and for ascertaining that the fall has taken place at the proper instant, but they do not call for special remark. The accuracy of the time-ball signal at 1 o'clock depends, he says, practically upon the error of the standard clock being accurately determined. If the weather has permitted transit observations to be made the previous evening, the error of course will be pretty closely known; otherwise the regularity of the rate of the standard clock must be trusted to. A table of the errors of the time-ball in 1885 is given, showing that the mean probable error of the signal for each month is about 0·2s.

The time service is at present confined to the dropping of this ball, but there would be, Dr. Doberck points out, no difficulty in dropping any number of time-balls along the coast or distributing hourly time-signals to the principal public buildings, &c.

The observatory possesses three chronometers, the rates of which are here given. Of the three, two keep mean-time, and one keeps sidereal time, but one of the former is useful only as a hack watch.

The equatorial of the observatory is the Lee equatorial, described by Admiral Smyth in the "Speculum Hartwellianum" and the "Celestial Cycle." The great length of the polar axis renders the instrument unsteady and sensitive to every motion of the observer. A Maclean star spectroscope has been fitted to it. The object-glass appears to be still in good condition.

The meteor shower (the Andromedes) of November 27 was observed, and it was estimated that about 2000 meteors an hour were visible, most being small; none being brighter than the first magnitude, and only a few so bright. The radiant was determined to be at R.A. 27°, Decl. 40° N., but it was at least 3° in diameter.

THE RAINFALL OF THE CAPE COLONY

OBSERVATIONS of rainfall were begun in the colony about forty-five years ago, but until 1876 no general system of registration was in force; and, except in the case of the Royal Observatory and a few other stations, no continuous records were available. In 1876, however, Mr. John G. Gamble, M.A., M.Inst.C.E., the Hydraulic Engineer to the Colony, induced the Government to grant a sum of 100*l.* for the purpose of establishing rain-gauges throughout the country. This grant has been continued yearly since then, with the result that, although the sum is quite inadequate for the speedy erection of the number required, there are now 250 gauges from which monthly returns are obtained. A gauge is placed at every seat of magistracy, and private persons are also supplied with gauges free of charge on condition that they observe continuously for five years, and forward monthly returns to the Meteorological Commission at Cape Town. All the services rendered by the observers are gratuitous. The monthly returns are tabulated and printed together with other meteorological observations in a report by the Meteorological Commission, which is presented annually to the Colonial Legislature.

At the end of 1883 there were 75 stations at which records had been kept for at least five years. An appendix showing the average rainfall for each month of the year at these stations was published by the Meteorological Commission in their 1883 report, and in their report of the following year some diagrams plotted from these averages were included, which show more strikingly than figures the fluctuation of the rainfall from month to month.

That the observations begun ten years ago are beginning to bear good fruit is evident from the series of rainfall maps exhibited in the Court devoted to the Cape of Good Hope at the Colonial and Indian Exhibition. There are sixteen maps altogether, fourteen of which have been compiled by Mr. Gamble and two by Mr. W. B. Tripp, F.R.Met.Soc. One of those by Mr. Gamble shows the position of the gauges and the districts into which the colony has been divided for the purpose of rainfall registration; the others represent, by means of different colours, the general distribution of rainfall for each month of the year and for the whole year. The contours on the maps for the various months show differences of 1 inch in the rainfall, starting from a contour indicating the area where the fall is less than 0·5 inch. The contours on the map for the year indicate differences of 12 inches, beginning at 6 inches, and going up to 54 inches. The number of inches of rainfall at the various places is marked in figures.

Mr. Tripp's maps are intended to show the relation between the physical configuration of the country and its rainfall—one map representing contour-levels every 1000 feet up to 4000 feet, and the other representing the mean annual rainfall.

A casual examination of the various maps is sufficient to show that the conditions which determine the rainfall are not the same for the whole of South Africa. Thus in the south-west district of the Western Province the chief portion of the rain falls in the winter months, while in the Eastern Province, and in Natal and the Orange Free State, the greater portion falls in the summer, from October to March. On the southern seaboard of the Cape Colony the rainfall is irregularly distributed throughout the year, the greatest monthly fall at any place varying from one-ninth to one-eighth of the total.

A glance at Mr. Gamble's map showing the distribution in the year, shows that the north-west part of the colony is almost rainless. With the exception of the tract occupied by the Namaqualand Mountains, the average yearly fall in this desert is less than 6 inches; at Pella, a village on the Orange River, the rainfall for the year is 2½ inches, one-fifth of which falls in May. Some of the months at this place are rainless. Throughout the greater part of the colony the yearly rainfall varies from 6 to 18 inches, the smaller falls being characteristic of the regions in the interior, generally known as "The Karroo," from 2000 to 4000 feet above sea-level, and of a plateau nature; while the greater falls are found nearer the sea, and in the mountainous parts. In the south-west district, excluding the Cape Peninsula, and on the narrow strip of country on the south coast, between Swellendam and Port Elizabeth, the yearly rainfall ranges from 18 to 30 inches, except in the forests of George and Knysna, where it exceeds 40 inches. In the Cape Peninsula the rainfall varies from 25 inches at the Royal Observatory to 54 inches on the south-east side of Table Mountain. In the eastern districts of the colony, and in the neighbouring territories, where the main portion of the rain comes in summer, the fall averages from 18 to 30 inches, with somewhat higher records from the Amatola forest region. There are doubtless many places in this great tract, notably in the Drackensberg, where the rainfall exceeds that shown on the maps, but there are no records to admit of the area being mapped.

With regard to the causes which determine the variation in the rainfall, Mr. Gamble has pointed out that this is due chiefly to the sea-currents and the prevailing winds. "Natal and the Eastern Province (of the Cape Colony) get their rains chiefly in summer, when the south-east trade wind blows," while "the western portion of the Western Province gets its rain mainly in winter with the north-west wind" (*Trans.* Philos. Society of South Africa). From whatever direction the rain may come, it seldom penetrates beyond the mountain-range which runs parallel to the coast. This barrier, as shown by Mr. Tripp's contour map, separates the elevated central plateau from the tract of lower country on the coast. During some of the summer months it would appear as if the south-east clouds were carried over parts of this barrier, but generally all the rainfall in the midland districts of the colony comes from thunder-showers of a very local character, heavy rain falling on one farm, while it is dry all round. It might be asked why, if the western portion of the Western Province gets its rain with a north-west wind, should the midlands not get their supply from the same source. To this Mr. Gamble answers: "We may note that the anti-trade of the Western Province comes apparently from a portion of the equatorial regions that is occupied by sea, while the north-west winds that blow in the Eastern Province, if they really keep their theoretical curvilinear path and are not interfered with by the height and temperature of the ground, come from a portion of the equator where there is land and consequently small evaporation."

As might be expected, the areas occupied by given rainfalls alter in position and size from month to month, but these fluctuations cannot well be described without the aid of maps. It may be noted, however, that in May, which marks the beginning of the wet season at Cape Town, the area over which the rainfall varies from 0·5 to 1·5 inch occupies nearly the whole of the colony. The maps for October to March are extremely interesting, as marking the gradual advance of the rains which come from the south-east. Concerning droughts and floods, Mr. Gamble has made the pregnant remark:—"It is frequently said that in such and such a year there was a drought in the colony; in another year, heavy floods in the colony. This way of speaking is incorrect, for, in consequence of the very distinct climates of the east and and west respectively, it is very rare that a drought occurs all over South Africa at the same time."

As the future prosperity of South Africa depends on irrigation, it is almost needless to point out the importance of the work done by Mr. Gamble. Considering the small outlay which has been incurred, the results are remarkable. Whether the work will in future be carried on in the same scientific spirit as it has been hitherto is somewhat doubtful in view of the backward tendency at present in course of development in the colony.

. THOMAS STEWART

FERDINAND STOLICZKA

IN an interesting memoir, published by order of the Government of India, Mr. V. Ball gives a sketch of the life and work of Dr. F. Stoliczka, for many years Palæontologist to the Geological Survey of India. This memoir appears in connection with the publication of the scientific results of the second Yarkand mission, of which Stoliczka was Naturalist, and during the return journey of which he met his untimely end.

Born at Hochwald, in Moravia, in May 1838, Stoliczka obtained his early education at Prague, from whence he proceeded to Vienna, where he took the degree of a Doctor of Philosophy. To Prof. Süess he was indebted for his first regular training in geology, and he received the kindliest help in palæontology from Dr. Hörnes, who was for some years Director of the Austrian Imperial Mineralogical Cabinet, and was well known by his researches on the Mollusca of the Vienna Tertiary. He died in the prime of life, but not before he had seen the firstfruits of Stoliczka's labours on the Cretaceous fossils of India. Stoliczka's first contribution to science was made (1859) to the Vienna Academy of Science as a memoir on some fresh-water Mollusca from the Cretaceous formation of the North-Eastern Alps, and in 1861 he became one of the staff of the Austrian Geological Survey, of which Dr. Haidinger was then the chief. Here he had the fullest opportunities of working at his favourite pursuit, and well does he seem to have availed himself of them. There was a conscientious accuracy as well as an extensive knowledge of his subject displayed in Stoliczka's writings of this period that early marked him out for a brilliant career.

In the year 1862 he received the appointment of Assistant to the Geological Survey of India, and was present with Dr. Oldham, the Superintendent of the Survey, at the meeting of the British Association at Cambridge over which Prof. Huxley presided. There are many who may still remember his slight figure, and dark hair brushed back: in after days he became rather stout. At that time he knew but a few words of English, but very shortly afterwards we find him not only speaking and understanding English well, but actually writing notes in his journal in English.

On his arrival at Calcutta he at once commenced to work on the Cretaceous fossils of Southern India, and the splendid series of memoirs on these forms, of which Part 1 appeared in 1863, was not completed until ten years afterwards. These memoirs, in which as to the Belemnites and Nautilus he was assisted by Mr. Blanford, form a work of over 1400 pages, illustrated by 176 plates, a record in itself of a laborious life. The work of arranging and describing the fossils collected by others was, however, only a small portion of the work performed by Stoliczka. He threw himself with ardour into everything that pertained to the natural history of his adopted country, and there was scarcely a division of the animal kingdom that he had not a tolerable acquaintance with, and to the published records of which he did not add something—Mammalia, birds, reptiles, molluscs, Polyzoa, arachnids, Crustacea.

From time to time his work took him from the Museum workshops, and he visited now the North-Western Himalayas, and again the Andaman Islands, and portions of Burmah. In all and every place he visited he found something new and interesting, and by the numerous papers which he published as the result of his travels, one might almost follow him in his journeyings.

In 1873 it had been arranged that Stoliczka should go to Europe to take charge in part of the splendid collection of minerals and fossils sent to the Great Exhibition of Vienna from the Geological Survey of India, but he was tempted to go instead as one of the mission from the Government of India to the King of Yarkand and Kashgar. On May 17 he left Calcutta on a journey from which he never returned. Yarkand was reached on November 8. Early in October, and shortly before crossing the Sanju Pass (16,500 feet high), Stoliczka had been seriously ill from apparently a slight attack of spinal meningitis, from which, however, he rallied, and he seems to have enjoyed the three weeks' sojourn at Yarkand. On December 4 Kashgar was reached, but the formal presentation to the King of Her Britannic Majesty's letters did not take place till January 10, 1874. In February an excursion was made to Artish and Kalti Ailak, and on March 17 leave was taken of the King, and the return journey to India commenced. Returning by Yarkand, the Kara-korum Pass was ascended on June 16, and Stoliczka seems to have suffered from the great height. On the 17th the last record appears in his journal. On the 18th the first symptoms of a new attack of spinal meningitis showed themselves, and, despite all the care of his devoted friends, he breathed his last on the afternoon of the 19th, some eleven marches from Leh, where he was buried beneath a willow-tree. The Government of India placed a suitable inscription over his grave, and other evidences of the esteem and regard in which his memory is held will be found in the Museums of Calcutta and Vienna. And now another, and this not the least, will be found in this too brief, but sympathetic, record of his life and labours, written by one who knew him well, and who was able to appreciate not only the scientific labours of his friend, but his honesty and loyalty. A detailed list of all the scientific papers and published letters of Stoliczka between 1859 and 1874 is appended to this memoir.

THE IRON AND STEEL INSTITUTE

THE summer meeting of this Institute was held on the 6th to the 8th inst., in London, under the presidency of Dr. John Percy, F.R.S. In his introductory remarks, the President made special reference to some of the papers about to be read. He was very pleased to see that the employment of chromium in the manufacture of steel was receiving attention. As far back as 1821 Bertheir, in the *Annales des Mines*, had shown that iron with 1 to 1·5 per cent. of chromium forged well, whilst it took a keen edge when ground, and had a very high tenacity.—Dr. Percy exhibited a portion of a broken ploughshare of American manufacture, which was formed of three metals, and seemed to be produced by casting steel on both sides of malleable iron. He drew attention to mitis metal, but refrained from offering any opinion on the subject, referring simply to the statements put forward that by the use of aluminium in its composition the melting-point was lowered, whilst, as the product was more liquid, it ran better, and sound castings were more easily produced. In speaking of Indian metallurgy, reference was made to the iron column at Delhi, the largest piece of forged iron in the world. The President next drew attention to the development of iron and steel-making in the United States, showing its rapid progress, and how enormously the capacity for production, both in that country and here, was in excess of the demand, as regarded blast-furnaces, Bessemer converters, and open-hearth furnaces. The address concluded with some remarks on diminished cost of production; to what a degree this has been carried, and the influence it has had on the labour market may be inferred from the circumstance that nowadays a single lace-making machine does the work formerly done by 2000 women, that wood-planing, which used to cost 12*s.* per square foot, is now done for 2*d.* or 3*d.*, that the manufacture of gold chains has been reduced from 30*s.* to 3*s.* 6*d.*, and that a gross of steel pens may now be procured for 4*d.* which used to cost 7*l.* Sir Henry Bessemer proposed a vote of thanks to Dr. Percy for his address, which was seconded by Mr. Adamson, the President-Elect.

The first paper read was that of Sir Frederick Abel, F.R.S., and Colonel Maitland, Superintendent of the Royal Gun Factories, Woolwich, on the erosion of gun-barrels by powder-products. This, in the author's opinion is due to a softening, if not fusing, effect exerted upon the surfaces of the metal by the high heat of the explosion, an increase of this softening or fusing effect by the chemical action of the sulphur at the high temperature produced, and the mechanical action of the rush of gases, vapours, and liquid products upon the softened or fused surfaces. There are two kinds of scoring or erosion: muzzle-loading scoring is due to the rush of powder-products over the top of the projectile through the clearance or windage, which has to be allowed for facility of ramming home the shot along the bore in a muzzle-loader; breach-loading scoring is produced by the rush of the powder products behind a shot, acting as a gas-tight plug, during and immediately after its passage through the gun. Evidently erosion will increase with the amount of the powder products, with the pressure in the bore, and with the duration of the time of action, and it is important to ascertain what material best resists erosion by powder products, or what treatment of the material is best calculated to increase its power of resistance to erosion. With this object in view experiments were made on thirteen rifled barrels, of different steels, of 2¼ inch bore, firing 100 rounds each with 10¼ lb. charges of pebble powder and 6 lb shot, fitted with service driving rings; these barrels were screwed into the mouth of the chamber of a 22 cwt. breech-loader. Gutta-percha impressions were taken after each batch of twenty-five rounds. During the preparation of the barrels specimens were cut in prolongation of the bores and tested mechanically, and the proportions of carbon, silicon, and manganese were determined in samples of the metal. The average pressure of the gas was 13 tons to the square inch. The results of the experiments are given in a table, but neither the chemical analysis of the metals nor the testing machine gave any assistance in accounting for the position of the barrels in the mean order of merit in which they were placed by five skilled and independent observers. Thus the worst and the worst but one were respectively the highest and nearly the lowest in carbon, the first, fifth, and tenth were very closely allied both in analysis and as tested by the machine, and it became evident that some agency, hitherto unsought for, dominated the results. Separate and independent investigations were made by the writers of the paper, the one instituting a chemical and the other a mechanical examination of the metals. A chromic solution capable of exerting a very slow solvent action upon the metals brought their structure into relief, and the extent of erosion was found to be more or less referable to the less or greater amount of mechanical treatment the metal had received, and to the consequent extent to which uniform fibrous structure had been developed. Experiments made on the metal as cast, and forged to twice to four times, and to eight times its length proved that the more steel was forged or worked the less it suffered from the eroding effect of powder gas. This was found to be the case both as regarded hard and soft metal. Several members took part in the discussion, notably Mr. Adamson, Sir Frederick Bramwell, Sir Henry Bessemer, and Mr. Frederick Siemens.

The next paper, which was taken as read, was an elaborate report of 137 pages in length by Messrs. P. C. Gilchrist and E. Riley, "On the Iron-making Resources of the British Colonies and India, as illustrated at the Colonial and Indian Exhibition." It would appear the reporters are of opinion that, so far as the exhibits are concerned, the iron and coal-producing power of the Empire is rather undershown, as with a proper application of the materials at the disposal of our colonies and India, they should at all events be able to supply their own requirements.

The next papers read were: "On some Early Forms of Bessemer Converters," by Sir Henry Bessemer, F.R.S., and "On Modifications of Bessemer Converters for Small Charges," by John Hardisty. The first of these contains descriptions of the different forms of converters selected by the author as typical of the whole, and which embrace the main features of ten several forms of apparatus which he has from time to time designed for the conversion of crude iron into steel. It was written with the double object of letting those who are seeking to improve the process know what has already been done; while the general public ought not to remain ignorant of what legitimately belongs to them, and which, after the ample reward he has received for his inventions, the author desires they should enjoy without any restrictions. The author of the second paper holds that the making of steel in small quantities is a step in the wrong direction, because the steel cannot be made so cheaply; but, as he points out, it is to the interest of owners of small blast plant to possess the means of converting their product into steel, and of ironworkers who cannot find work for their puddling furnaces to make steel enough to keep their machinery at work rather than be dependent on larger firms for a supply of ingots. An American steel-maker in the discussion drew attention to the circumstance that in the United States, when the rail trade was brisk, it was impossible for the smaller works to obtain Bessemer ingots at all, and that they had to introduce small plant for self-preservation. From the statement of opinion it was evident that there was necessity for the original Bessemer converters and the smaller modified forms.

Mr. Frederick Siemens's paper on combustion with special reference to practical requirements draws attention to the means necessary for adoption to insure perfect combustion. The gases must be supplied in the exact chemical proportion in which they are required for combustion; they must be brought together in such a manner that the different molecules which have to enter into combination may readily do so, whilst every thing must be avoided which interferes with the motion of the gases while combustion is proceeding.

The author enters in detail on the way in which gases should be brought together, he explains that the Bunsen burner, though theoretically perfect, cannot be advantageously carried out in furnaces, as the flame of a Bunsen burner being almost non-luminous owing to free carbon not being liberated during combustion, has but little radiating power, and must in consequence transmit its heat by direct contact only. As the gases cannot generally be mixed before combustion, it is a matter of great importance how they are brought together when combustion commences, a mean being necessary between a too intimate mixture, producing a short flame having great heating but little radiating power, and an imperfect mixture, which does not allow of combination properly taking place. The third means necessary is the one to which the author has frequently drawn special attention, because neither the employment of gases in proper proportion, nor their proper mixture is sufficient to insure perfect combustion *if the disturbing influences of surfaces is allowed to interfere to prevent combustion, or to dissociate particles of gas already combined.* In the author's view the dissociation caused by hot surfaces is of various kinds, and takes place at different temperatures. At a comparatively low temperature, dissociation of hydrocarbons takes place, the carbon being liberated in the solid form as soot. At a moderately high temperature carbonic oxide is dissociated into solid carbon and carbonic acid gas; at a higher temperature the products of combustion begin to dissociate, steam splitting up into hydrogen and oxygen, and lastly, at a still higher temperature, depending upon the kind of surface with which the products of combustion come into contact, carbonic acid splits up into solid carbon and oxygen. From this it will be seen that dissociation has the effect of setting carbon free, and to its influence the formation of smoke is largely due.

The author then proceeded to show that smoke within a furnace chamber is caused by flame in the first instance touching surfaces which then become enveloped in a dense cloud of dissociated carbon, which prevents the heat rays from reaching them. The author illustrated his remarks by means of a gas-burner proposed to be used instead of the English fire-place, by the use of which it is stated that heat is much more uniformly distributed throughout a room. The flame was intensely bright and hot, due as explained to its being fed with hot air, and working with free development of flame that is entirely out of contact with any surfaces. The gas stove afforded considerable interest to the members, and the author by special request explained its mode of action.

The papers read on the last day of the meeting were two by Mr. F. Gautier, of Paris, on the casting of chains in solid steel, and on silicon in foundry iron. Hitherto chains have been made of wrought iron, the difficulty in the various processes of manufacture being the difficulty of securing a good weld; this, according to the author, is now overcome by a process of Messrs. Joubert and Leger, of Lyons, which combines chilled casting and instantaneous removal from the moulds. In the second paper the writer refers to the advantage of silicon in producing homogeneous steel and pig iron castings and improving foundry pig; he also drew attention to the introduction of ferrosilicon in French foundry practice. The author's views were in general supported by the members in discussion. Mr. F. W. Harbord's paper, "On the Elimination of Silicon, Phosphorus, &c., in the Basic Open-hearth Process," gave evidence that soft steel of the very finest quality could be produced from inferior material by this process, whilst the conditions of working in the Siemens furnace are peculiarly favourable to its production. Surgeon-Major Hendley's paper, "On the Process employed in Casting Brass Chains at Jeypore, Rajputana," was contributed by Mr. C. Purdon Clarke, and illustrated by samples. The papers on "Chrome Steel," by Mr. Brustlem, and on "American Blast Furnace Practice," by Mr. F. W. Gordon, Philadelphia, were put off to the next meeting.

NOTES

WE regret to learn that Baron von Müller retires from the directorship of the Melbourne Botanic Gardens in June next.

THE death is announced of M. Dubosc, a Paris optician, who assisted M. Léon Foucault in all his constructions, and especially in the organisation of his automatic electric lamp.

THE Laboratoire d'Électricité created with the surplus of the Electrical Exhibition of 1881, held in the Palais de l'Industrie, will be erected on the site of the old Collège Rollin, on ground granted by the City of Paris. It will be open to electricians of every nation, and governed by the International Society of Electricians.

AN ordinary General Meeting of the Institution of Mechanical Engineers will be held in the Yorkshire College, Leeds, on Monday, October 18, by invitation of the College authorities, in celebration of the opening of the Engineering Department of the College. The following papers will be read and discussed, as far as time permits:—"On Triple-Expansion Marine Engines," by the late Mr. Robert Wyllie, of Hartlepool; "Notes on the Pumping Engines at the Lincoln Water-Works," by Mr. Henry Teague, of Lincoln; "Description of a Portable Hydraulic Drilling Machine," by M. Marc Berrier-Fontaine, of Toulon.

THE Commission of the French Budget having adopted without reduction all the proposals of the Government for the Algerian provinces, the construction of the large instruments for Bouzareah Observatory will be continued, and inspection of the heavens will be conducted on a large scale at Algiers. An observer connected with the Trocadero Observatory has been appointed to assist M. Trépied, and left Paris last week for his destination.

THE photographic method has been established at the Algiers Observatory for the sun. Nine times out of ten the operation has been successful.

THE Duc d'Aumale has bequeathed to the Institute of France in perpetuity the mansion and domain of Chantilly, with its museum and all its other contents, to be preserved and maintained for the benefit of the French nation. This munificent gift is fettered by no conditions beyond those necessary for carrying out the main purpose of the testator. The value of the gift is estimated at thirty millions of francs, or nearly a million and a quarter sterling, and the income for maintaining it at 20,000*l.* per annum.

SOME time since, Herr Paul von Ritter, of Basle, gave the sum of 300,000 marks for the furtherance of scientific inquiry on the basis of the Darwinian theory. It has now been decided to employ half the interest in the maintenance of a "Ritter Professorship of Philogeny." The chair is to be filled by Dr. Arnold Lang, formerly scholar and assistant of Prof. Haeckel at Jena. Dr. Lang has for several years taken part in the work of the Zoological Station at Naples. The other half of the interest will be expended in grants for scientific travel, and in furnishing improved means of instruction in zoology at this University. Herr von Ritter has been made Doctor of Philosophy *honoris causâ.*

SINCE the end of 1883, regular observations of atmospheric electricity have been made at the Odessa Meteorological Observatory, and M. Klossofsky shows by the graphic method (*La Nature*) how there is an intimate relation between the variations of atmospheric pressure, and those of electric potential. Cyclonic movements of the atmosphere find a faithful echo in the indications of the electrometer, though sometimes mist, smoke, dust, and atmospheric precipitates may for a time mask the correspondence.

IN the course of a review in the *Chinese Recorder* of a new Chinese geometry by Dr. Mateer, Dr. Martin, the head of the Foreign Language College at Pekin, states that the first translation of Euclid into Chinese was made by the illustrious Father Ricci, "the apostle at once of religion and science." In time the paramount influence of Euclid grew into something like a bondage in the east as well as in the west. In the west a wholesome revolt took place long ago, but in China Euclid "has reigned with undisputed sway for three centuries, and nothing has been done even in the way of simplification until the work of Dr. Mateer. It is a strange fact that Ricci's Euclid was left standing through all these ages in the condition of a truncated pyramid. Only six books were translated by the great Jesuit, and the remaining nine were supplied about thirty years ago by Mr. A. Wylie, aided by Prof. Li Shenlon." Mr. Wylie subsequently translated Loomis's "Analytical Geometry and Differential Calculus"; but, says Dr. Martin, he would have done better to have commenced his mathematical text-books by a version of Loomis's "Geometry," which, following the footsteps of Legendre, presents the whole subject in a compact and easily intelligible form. The translation of the Chinese titte of the older book is "First Book in the Science of Quantity"; that of Dr. Mateer's is "The Science of Form." A Chinese mathematician's view of the new work is given by Dr. Martin in the following words:—"This book presents the principles of geometry in a more concise form than Euclid, and omits nothing of importance that is found in Euclid. Besides the chapter on the three round bodies, there are throughout many excellent theories that were unknown to Euclid, especially those relating to spherical triangles, so essential to the study of astronomy." The price of the two volumes, it may be added, is about 2*s.* 3*d.*

THE number of the *Folk-Lore Journal* (vol. iv. part 4) just published, contains the first instalment of a paper by Capt. A. C. Temple, which promises to be the most important work yet published on the folk-lore of North-Western India. The writer has made it a practice to collect all the popular works published in the Punjaub relating to history, folk-lore, and religion. He has now about 350 of these in Arabic, Persian, Urdu, Hindi, Punjaubi, Pushtoo, and Sanscrit. It faithfully represents the current popular literature of the day in the Punjaub. Capt. Temple has had abstracts of the books prepared, and twenty-eight of these are published in the present paper. In the somewhat distant future when the whole 350 are published, few regions will have had their folk-lore so thoroughly investigated as the Punjaub.

ACCORDING to *Die Natur* a remarkable collection of minerals exists in the cellars of the Academia San Fernando at Madrid. It is contained in a number of boxes which have filled the cellars for about 200 years, and which may remain there as long again unless some better fortune befalls them than that which has attended them in the past. They come down from the golden age of Spanish domination in South America and in Mexico, when the mines of these regions made them the El Dorado of the globe. No one knows exactly the contents of the boxes, but they are believed to contain the rarest objects, although the scientific importance of collections was but little appreciated in the days when this one was made. It appears also that collections made by Humboldt during his travels in America, and handed over by him as a kind of scientific tribute to the Spanish Government, are in the same Academy "locked up since 1804 in a press, untouched." With respect to the famous skeleton of the *Megatherium americanum*, Cuv., found by the Marquis de Loreto on the banks of the Rio Luxon near Buenos Ayres in 1778, which is in the Museum of the Academy, its present state is described by the brothers Fraas of Stuttgart in their letters from the south of France and Spain, just published under the title of "Aus dem Süden," as being one of the utmost confusion. The bones are bored for mounting, but they are "completed and restored" to the verge of the impossible. The bones are placed in absurd positions, and parts which were inconvenient to the mounter are put aside altogether. The writers ask what the state of instruction in natural history must be in an Academy where such things are possible.

WE have never heard an adequate explanation of the extraordinary delay which takes place in the issue of the Annual Reports of the Japanese Ministry of Education. They are as a rule three years behind time. That for 1882 has only just been published. They contain a considerable number of statistics, but this alone would not account for the delay, for the publications of, say, the Japanese Meteorological Observatory contain far more and more complicated tables, yet the latter appear in reasonable time. It is very difficult to feel any interest in an annual report of the year 1882 at this date; conditions have altered, the circumstances are different, the inspector's report for 1885 may show energy and success where those of 1882 had to reveal apathy and ignorance. The Tokio University, for example, has been wholly remodelled, and one reads with very languid interest now that in 1882 there were such and such departments, so many graduates, and the like. The details in the report, especially those relating to students abroad, to the position of libraries and museums, their utility to and appreciation by the public, would be of interest and well worth quotation, or at least a short summary, if they were those of last year instead of those of four years ago. These reports may perhaps be of use to any one who undertakes to write a history of education in Japan; for any practical present use they are they might as well remain unpublished in the Archives of the Education Department in Tokio. We can perceive nothing in the nature of things, or in the design or details of the reports to prevent them being produced regularly in the first half of the year succeeding that to which they refer.

In a very interesting paper in the new number of the *Asiatic Quarterly Review*, Miss E. M. Clerke, writing on "Arabic Analogies in Western Speech," says that whole classes of astronomical, astrological, and generally scientific terms are a standing memorial to the debt of culture Europe owes to the East. Logarithm is a corruption of *el-jouarzeem*, and algebra of *el-jabr wa'lmukábala*, literally, the integration and comparison. Alembic is *el-anbik*, a retort, whence the Italian *lambiccare*, to distil; and nearly all the terms used in alchemy denote its Oriental origin. Star-names come from the same source: Algol is *el-ghol*, the ghoul; and Vega, a fragment of *nasser-el-waga*, the falling eagle. Most precious stones and minerals, as sapphire, emerald, bezoar, jasper, amber, antimony, are transparent disguises of Arabic originals; jewel itself is from *jouhour*. Similarly the names of poisons and remedies, as well as maladies, come from Arabia: thus arsenic is *ez-zernikh*; massage, the fashionable cure by friction, is from *mass*, to handle, and leprosy is an obvious corruption of *el-abras*. Again, such words as spinach, endive, chicory, saffron, arrowroot, cotton, hemp, carraway, cummin, and aloe are obvious derivatives from Arabic. The names of many flowers come from Arabia, by adoption from Persian, also fruits, as lemon and orange. Carat is an Arabic weight. Monsoon comes from *mousem*, a fixed time, and sirocco and simoom. These and a hundred others given by Miss Clerke "go to prove that the world is one vast commonwealth of ideas, most widely shared by the classes least conscious of their indebtedness to foreign influence."

Father Dechevrens, of the Siccawei Observatory near Shanghai, writing on a violent typhoon which visited that district on August 14, doing considerable damage, says that it was remarkable by the long persistency of the low pressures that continued from 3 a.m. on the 14th to 5 a.m. on the 18th, that is, ninety-three hours, during the whole of which time the wind blew hard, and during the two last days the rainfall rose from 6 inches to 12. He says this is a singular and very rare phenomenon, and to explain it he follows the typhoon all along its course. Like the typhoon of the same date in 1881, it came from the open sea. On the 11th the barometer at Manilla caused suspicion of a storm to the north-east of Luzon and east of Formosa. The Loochoo Islands must have been passed on the afternoon of the 13th, and at noon on the 14th it reached the coast of China about Wenchow. Having got to the mainland, the storm proceeded for some time to the west through the province of Kiangsi, and then was divided. One part recurved to the south-west towards Kwangsi and Tonquin, and is easily followed by observations made at Amoy and Hong Kong; the other part of the depression turned round to the north and got nearer to the Yang-tse River. On the morning of the 18th an entire change took place in the atmospheric conditions. The second depression was in its turn divided, and while the portion higher in latitude formed itself into a distinct storm and got away to the north, the other part approached Shanghai and put back to sea through the mouth of the Yang-tse. When Shanghai was placed between the two depressions, the air, not knowing, as it were, towards which of them to flow, got rapidly calm. While the two centres were thus getting away in opposite directions, the Siccawei barometer rose without any strong wind blowing. This, concludes Father Dechevrens, is a new phase of this singular typhoon, the centre of which passed very close to Shanghai without giving birth to any gale, except the one that had preceded the division and the departure. It is to be hoped that the learned writer may be able to give this typhoon, with the peculiarities here noted, the same detailed and thorough study that he gave that of 1881. In the latter instance he gave what may be called the life-history of a storm from its birth in the China Seas, almost to its dissipation far in the interior of he continent of Asia.

The luminosity of insects has been lately studied in a very careful manner by Dr. Dubois, one of M. Bert's students. The animal selected was the American *cucujo*, or *Pyrophorus noctilucus*. It has three luminous organs—two prothoracic and one ventral. Dr. Dubois opposes the view that the light results from direct oxidation of the substance of the luminous organs, by oxygen of the air coming through the tracheæ. In pure oxygen the luminosity is the same as in air, and it is the same in pressures under one atmosphere. Nor does compressed oxygen affect it, and this gas cannot restore the light when extinct in organs which yet respond to mechanical agents or electricity, even when the pressure is raised to four atmospheres. The prothoracic plates give a good illumination in front, laterally, and above, and serve when the insect walks in the dark; when it flies or swims, its fine abdominal lantern is unmasked (and the abdomen raised) throwing downwards an intense light with much greater range. The insect seems to be guided by its own light. If the prothoracic apparatus is quenched on one side with a little black wax, the cucujo walks in a curve, turning towards the side of the light. If both sides are quenched, the insect walks hesitatingly and irregularly, feeling the ground with its antennæ, and soon stops. The light of the cucujo gives a pretty long spectrum from the red to the first blue rays; when the light diminishes, this shortens somewhat on the side of the blue, but more on the other side. The maximum is about wave-length $528\,\mu\,56$ (as in the solar spectrum). The light is more green than that of *Lampyris noctiluca*. It is capable of photography, but does not develop chlorophyll. The prothoracic organs of six insects did not set a radiometer in motion, but they affected a Melloni pile slightly. No distinct electric action could be traced in the organs. Separated from the body, the organs are still brilliant. If the insect is deprived of water, it ceases to produce light; and it recovers the power when plunged in water. The eggs may be dried to the extreme limit, at ordinary temperature, without losing their light-yielding power; put in water after eight days even, they become luminous again. Further, if the luminous organs are dried *in vacuo*, and pulverised in a mortar, a little water (even if freed from gas by boiling) makes the mass luminous throughout. Dr. Dubois finds the photogenic substance to be an albuminoid, soluble in water and coagulable by heat; it enters into conflict with another substance, of the diastase group, and part of the energy thus liberated appears as light.

Some experiments lately brought before the Paris Academy by M. Luvini, combine with those of other observers (he considers) in warranting the conclusion that "gases and vapours, under any pressure, and at all temperatures, are perfect insulators, and cannot be electrified through friction, either with one another, or with solid or liquid substances."

The *Giornale d'Agricoltura e Commercio* for August reports the discovery in West Africa of a new variety of coffee-plant, whose berry appears greatly to resemble that of Arabia in appearance and flavour. It grows, however, not on a shrub but on a tree nearly 7 feet high, which develops rapidly and yields an abundant crop. Arrangements are already being made for introducing its cultivation in favourable localities.

The additions to the Zoological Society's Gardens during the past week include a Brown Capuchin (*Cebus fatuellus* ♀) from Guiana, presented by Messrs. Kühner, Hendschel, and Co.; a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by the Countess de Geloes; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus* ♀) from South Australia, presented by Mr. G. Langborne, Chief Officer s.s. *Rome*; a Common Squirrel (*Sciurus vulgaris*), British, presented by Miss Gertrude Hudson; two Lanner Falcons (*Falco lanarius*) from Eastern Europe, presented by the Baron D'Epremesnil; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mrs. George Quish; a Gannet (*Sula bassana*), British, presented by Mr. J. H. Gurney, F.Z.S.; two Common Chameleons (*Chamæleon vulgaris*) from North Africa, presented respectively by Mr. Charles T. Port, F.Z.S., and Mr. T. H. Carlton Levick; a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a Porto Rico Pigeon (*Columba corensis*), a Triangular-spotted Pigeon (*Columba guinea*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

M. THOLLON'S MAP OF THE SOLAR SPECTRUM.—M. Thollon, in the *Bulletin Astronomique* for July, gives some interesting details concerning the great map of the solar spectrum which he presented to the Paris Academy of Sciences about a year ago. He had completed an earlier design in 1879, but the positions of the lines in it had not been determined with the precision he desired. He therefore resolved to go over the work again, and to make a chart which should represent the positions, breadths, and relative intensities of the lines as faithfully as possible. The work has required four years of continuous toil to carry it from A to *b*, at which point M. Thollon now leaves it. M. Trépied proposes to carry it on to the violet. M. Thollon's map shows the spectrum under four different aspects: as seen when the sun is 10° high, and the air contains but little water-vapour; then as with the sun at 30° of altitude, first with the air saturated with water-vapour, and next when the air is very dry; and, lastly, the solar spectrum as it would be seen outside our atmosphere. It is therefore easy to see which lines are truly solar, which due to water-vapour in our atmosphere, and which to dry air. M. Thollon finds the dry-air lines limited to the great groups A, B, and α, which M. Egoroff ascribes to oxygen. Besides the water lines, which are arranged in seven groups, M. Thollon on a single occasion observed a vast number of telluric lines between α and D, the special origin of which he was not able to determine.

The measures were made with a very fine glass pointer, which allowed a bisection of a line to be made with great exactness, the probable error of an observation being less than 1/700 of the interval between the D lines. The breadth of a line was determined by observing at what distance from its extreme point, the glass pointer was equal to it in breadth. The intensity of the lines were estimated by eye. The map, which will be published in the *Annales de l'Observatoire de Nice*, is more than 33 feet in length, and embraces more than a third of the visible spectrum. From the scale on which it is drawn, the number of lines—about 3200—which it contains, the precision of the measures, and the fullness of the information given concerning the telluric lines, it will be, that which its author has striven to make it, the fullest and most perfect chart of the spectrum yet published. One of the chief purposes which it will serve will be to afford information as to the occurrence of changes in the spectrum, and M. Thollon shows by a diagram of the spectrum between B and C that we have strong reason to suspect that several lines have greatly altered in intensity since the date of Ångström's famous chart.

COMET FINLAY.—Mr. Finlay, of the Cape of Good Hope Observatory, discovered a comet on September 26. It appears to be probably identical with Comet 1844 I., its elements being given by Dr. Holetschek as follows:—

T = 1886 Nov. 22·6821 Berlin Mean Time.

$$\left.\begin{aligned} \pi - \Omega &= 299^\circ\ 14'\ 21'' \\ \Omega &= 48\ 35\ 55 \\ i &= 3\ 23\ 0 \end{aligned}\right\} \text{Mean Eq. } 1886{\cdot}0.$$

$\log q = 0{\cdot}08793$

Ephemeris for Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Log *r*	Brightness
Oct. 19	18 8 10	26 40·2 S.	0·1442	0·1249	1·37
23	18 21 52	26 33·9	0·1410	0·1173	1·44
27	18 36 11	26 22·2	0·1378	0·1105	1·50
31	18 51 6	26 4·7 S.	0·1347	0·1044	1·57

The brightness on September 26 is taken as unity.

NEW MINOR PLANET.—A new minor planet, No. 260, was discovered by Herr Palisa at Vienna on October 3.

NEW COMET.—A new comet was discovered by Mr. E. E. Barnard on October 4. It was independently observed by Dr. Hartwig on the following night. October 5, 16h. 2m. G.M.T., R.A. 10h. 37m. 24s.; Decl. 1° 3′ N. It is described as bright and round. Daily motion + 1·5s. in R.A., and + 3′ in Decl.

THE PULKOWA OBSERVATORY.—M. Struve has issued his Annual Report for the year ending May 25, 1886. During the year the fundamental determinations of star places for 1885·0 were regularly persevered in with the great transit instrument and the vertical circle. With the former Herr Wagner and his assistants, Wittram and Harzer, observed 4785 transits. With the exception of 110 observations of the sun these refer exclusively to the 383 Pulkowa fundamental stars. With the vertical circle Herr Nyrén obtained 739 complete observations, including 105 observations of the sun. The fundamental declination determinations for 1885 would be almost completed, had not Herr Nyrén wished to repeat the observations with a reversion-prism eye-piece attached to the instrument in order to investigate certain systematic discordances. Herr Romberg, observing with the meridian-circle, obtained during the year 4359 observations, chiefly of stars with large proper motion, comet stars, &c. The great 30-inch refractor has been intrusted to Hermann Struve, and has been employed in observing the fainter double stars of Burnham's catalogues, the satellites of Mars, Saturn, and Neptune, the Maja nebula (discovered photographically at Paris), and *Nova* Andromedæ, which was easily visible on January 27. M. Struve speaks in terms of the highest approval of the instrument, both as regards its optical power and as regards the mounting, the movement of the dome, &c. The 15-inch refractor has been used by H. Struve for obtaining micrometer measures of the brighter satellites of Saturn. He has obtained 42 comparisons of Japetus with Titan, 40 of Titan with Rhea, and 23 of Rhea with Dione. Herr Backlund has continued in charge of the 4-inch heliometer, and has measured with it the relative positions of Jupiter's satellites, for a determination of the mass of Jupiter, and of the orbits of the satellites. He has also undertaken a series of measures to determine the parallax of Bradley 3077, which has a large proper motion. In the physical department of the Observatory Herr Hasselberg. using a Steinheil objective of 50 mm. aperture and 1·5 m. focal length, in combination with two bisulphide of carbon prisms, has succeeded in obtaining excellent photographic images of the solar spectrum. Between wave-lengths 4000 to 4227 on Ångström's scale, he was able to count some 650 lines, whereas Vogel's map gives but 450 in the same space. During the course of the year 140 sun pictures were taken on 110 days.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *OCTOBER* 17–23

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

At Greenwich on October 17

Sun rises, 6h. 29m.; souths, 11h. 45m. 24·2s.; sets, 17h. 2m.; decl. on meridian, 9° 20′ S.: Sidereal Time at Sunset, 18h. 46m.

Moon (at Last Quarter on October 20) rises, 19h. 15m.*; souths, 2h. 55m.; sets, 10h. 42m.; decl. on meridian, 16° 55′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 46	12 34	17 22	14 33 S.
Venus	5 18	11 4	16 50	3 32 S.
Mars	10 45	14 43	18 41	22 45 S.
Jupiter	5 52	11 25	16 58	6 3 S.
Saturn	21 51*	5 53	13 55	21 19 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich)

Oct.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
17	111 Tauri	5½	19 24	20 14	69 240
17	117 Tauri	6	21 9	21 17	339 322
23	B.A.C. 3538	6½	0 53	1 23	348 274
23	44 Leonis	6	2 6	2 38	344 271
23	B.A.C. 3562	6½	2 14	2 49	347 268

Oct.	h.	
20	7	Saturn in conjunction with and 3° 16′ north of the Moon.
21	4	Mercury at greatest distance from the Sun.
22	21	Venus in conjunction with and 0° 18′ north of Jupiter.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.
U Cephei	0 52·2 ...	81 16 N. ...	Oct. 19,	5 11 *m*
R Sculptoris ...	1 21·7 ...	33 8 S. ...	,, 22,	*M*
Algol	3 0·8 ...	40 31 N. ...	,, 19,	5 25 *m*
			,, 22,	2 14 *m*
λ Tauri	3 54·4 ...	12 10 N. ...	,, 18,	0 46 *m*
			,, 21,	23 38 *m*
R Canis Minoris...	7 2·4 ...	10 12 S. ...	,, 21,	*M*
S Cancri	8 37·4 ..	19 27 N. ...	,, 21,	4 38 *m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 18,	4 25 *m*
		and at intervals of		20 8
β Lyræ...	18 45·9 ...	33 14 N. ...	Oct. 18,	0 0 *m*
			,, 21,	5 0 *M*
η Aquilæ	19 46·7 ...	0 43 N. ...	,, 19,	2 0 *M*
			,, 23,	21 30 *m*
δ Cephei	22 24·9 ...	57 50 N. ...	,, 18,	2 0 *m*

M signifies maximum ; *m* minimum.

Meteor Notes

There are a large number of active radiants visible during the present week, the chief shower being the *Orionids*, R.A. 90°, Decl. 15° N. Other radiants are that of the *Arietids*, R.A. 31°, Decl. 9° N. ; near ψ Aurigæ, R.A. 78°, Decl. 32° N. ; that of the *Gemellids*, R.A. 108°, Decl. 24° N. ; near μ Leonis, R.A. 143°, Decl. 28° N. ; and near Vega, R.A. 283°, Decl. 43° N. October 18 is a fireball date.

THE NEW ELEMENT, GERMANIUM[1]

SOME months ago Dr. Clemens Winkler announced the discovery of a new element which he named germanium, a preliminary account of which has already appeared in these columns. Dr. Winkler has since been able to make a more systematic examination of the subject, and he now describes in detail the preparation and properties of the new element and also of a number of its compounds. The view he first held, that germanium occupied a position in the periodic system intermediate between antimony and bismuth, he now shows to be untenable, there being now no doubt that it is the *ekasilicium* of Mendelejeff prophesied fifteen years ago. This latter view was, in fact, expressed by Richter, Mendelejeff, and Lothar Meyer shortly after the discovery of germanium.

The new element occurs, as previously stated, in the recently-discovered mineral, argyrodite. Its isolation is, however, difficult, especially from the presence of arsenic and antimony in minerals which accompany argyrodite. The formula assigned to the latter mineral is $3Ag_2S,GeS_2$.

The following is the best method for separating the germanium. The finely-powdered mineral is intimately mixed with an equal weight of soda and sulphur, and the whole submitted to the action of a moderate red heat in a Hessian crucible. The product is powdered whilst still warm, and repeatedly boiled with water; the aqueous extract is slightly acidulated with sulphuric acid, and the precipitated sulphides of arsenic and antimony allowed to settle. On then adding a considerable excess of hydrochloric acid, the germanium sulphide is thrown down as a white voluminous precipitate; this is gently roasted, then heated with concentrated nitric acid, and finally ignited. The germanium oxide obtained may be reduced by ignition in hydrogen.

Germanium has a melting-point apparently somewhat lower than that of silver—that is, about 900°—and at a temperature a little higher than this it appears to volatilise. It crystallises in octahedra, is extremely brittle, has a perfect metallic lustre, and a grayish-white colour ; its specific gravity is 5·469 at 20°·4. It is insoluble in hydrochloric acid, is readily dissolved by aqua regia, is converted into a white oxide by nitric acid, and into a soluble sulphate by concentrated sulphuric acid.

Determinations of the atomic weight of germanium were made by estimating the percentage of chlorine in the chloride, $GeCl_4$, and the number 72·32 was obtained as the mean of four experiments, this number agreeing closely with the atomic weight of Mendelejeff's ekasilicium.

The specific heat of the new element has been determined by Nilson and Pettersson, at temperatures between 100° and 440°, with the following results :—

[1] Clemens Winkler, *Journal f. prakt. Chemie*, 1886, pp. 177-229.

	1	2	3	4
Specific heat ...	0·0737	0·0772	0·0768	0·0757
Atomic heat ..	5·33	5·58	5·55	5·47

Compounds of Germanium.—Oxides : There are two oxides of germanium, namely, GeO and GeO_2. The former is obtained in the hydrated condition by heating the corresponding chloride ($GeCl_2$) with sodium carbonate solution ; on heating the precipitate in a current of carbonic anhydride, the water is expelled and the grayish-black oxide, GeO, remains. The higher oxide is obtained by burning germanium in oxygen, or by decomposing the chloride, $GeCl_4$, by water ; it forms a dense white powder slightly soluble in water, possesses both basic and acid properties, the latter being, however, the more pronounced. *Sulphides:* Two of these are likewise known, corresponding to the oxides. The lower sulphide, GeS, is obtained from the disulphide either by heating it with an excess of germanium in a current of carbonic anhydride, or by gently igniting it in a current of hydrogen ; it forms beautiful thin plates of almost metallic lustre and having a gray-black colour. Germanium disulphide, GeS_2, is obtained by precipitating a solution of the dioxide by sulphuretted hydrogen with the addition of a considerable excess of a mineral acid ; it is then thrown down as a bulky white precipitate which is very appreciably soluble in water. *Chlorides :* The dichloride, $GeCl_2$, is formed when hydrochloric acid gas is passed over heated pulverulent germanium or its sulphide ; it is a thin colourless liquid, which fumes strongly on exposure to the air. The tetrachloride, $GeCl_4$, is produced by burning germanium in chlorine, or by distilling a mixture of germanium with mercuric chloride ; it is a thin colourless liquid boiling at 86° C. and fuming in the air ; its specific gravity at 18° is 1·887. *Iodide :* A tetriodide, GeI_4, only is known, and is best obtained by heating germanium in iodine vapour ; it forms a yellow powder, melts at 144°, and boils between 350° and 400°.

AUSTRALASIA

THE following have been quite recently received from Australasia :—

Transactions and Proceedings of the New Zealand Institute for 1885, vol. xviii. (first of new series) (Wellington, May 1886). This volume commences a new series of these well-known *Transactions*, in which, "for convenience and economy" the size of the page has been reduced from the handsome royal octavo to a demy octavo size. The volume contains over 450 pages, and some 17 plates. Among the more important contributions which are printed in the *Transactions* may be noted the following :—*Miscellaneous :* E. Tregear, the Maori in Asia.—Dr. J. Haast, stone weapons of the Moriori and the Maori.—Rev. S. W. Baker, new volcano in the Friendly Islands.—*Zoology :* T. Jeffery Parker, skeleton of Notornis.—T. White, feathers of two species of Moa.—A. Reischek, numerous papers on New Zealand birds.—W. Colenso, on the bones of a new species of Sphenodon.—W. W. Smith, on the habits of *Ocydromus australis*.—J. W. Kirk, on a new species of Argonauta.—Geo. M. Thomson and Chas. Chilton, critical list of New Zealand Crustacea Malacostraca.—E. Meyrick, New Zealand Micro-Lepidoptera (Tineina, Pars.).—A. T. Urquhart, on the spiders of New Zealand (many new species described and figured).—J. W. Kirk, on some species of Vorticella from Wellington describes thirteen species, of which two are given as new, and figured.—*Botany :* W. Colenso, on some newly-discovered cryptogamic plants of New Zealand, describes some fifty-nine species ; two ferns, fourteen mosses, and forty-three Hepaticæ, and hints that it may be the last lot of novelties that, owing to age, he may himself collect and describe.—On some new or rare native plants, chiefly phanerogams ; on *Clianthus puniceus*, Sol.—D. Petrie, on new species of native plants.—R. M. Lang, on classification of Algæ, and on the Fucoids of Banks Peninsula.—T. F. Cheeseman, three new species of Coprosma.—T. Kirk, additions to the flora of Nelson.—*Geology :* Capt. F. W. Hutton, the geology of Scinde Island ; new Tertiary shells ; the Wanganui system, with a catalogue of the Mollusca.—A. McKay, on the age of the Napier limestone.—*Astronomy :* Notes on the total eclipse of the sun of September 9, 1885, being a digest of many communications.—*Chemistry :* W. Skey, on a new mineral (awaruite) from Barn Bay.—W. S. Hamilton, on platinum crystals in the ironsands of Orepuki Goldfield.

Proceedings of the Linnean Society of New South Wales, vol. x. part 4, with 18 plates (Sydney, April 1886).—Dr. R. von

Lendenfeld, studies on Sponges: (1) the vestibule of *Dendrilla cavernosa*, sp.n.; (2) on *Raphyrus luxonii*, a new gigantic species from Port Jackson; (3) *Halme tingens*; (4) two cases of mimicry in Sponges (plates 39-43).—On recent changes in the forest flora of the interior of New South Wales; notes how the Pine Scrub (Callitris) rapidly supersedes the angiospermatous trees. The larva of a beetle (*Diadoscus erythrurus*) in part keeps the pine in check; drought seems favourable to the development of the beetle, or at least, by affecting the vegetation of the pine, enable its ravages to be more felt.—On the Australian fresh-water Rhizopoda.—On an Alga forming a pseudomorph of a siliceous Sponge.—On the dorsal papillæ of Onchidium.—Fourth addendum to the Australian Hydromedusæ.—E. P. Ramsay and J. Douglas-Ogilby, descriptions of many new or rare fishes.—George Masters, catalogue of the described Coleoptera of Australia, part 2.—N. de Miklouho-Maclay and Wm. Macleay, the Plagiostomata of the Pacific, part 3 (plates 45, 46).—A. Sidney Olliff: Trogositidæ of Australia.—On a new species of Chrysophanus.—On Australian Ptinidæ.—W. A. Haswell, on some Australian Polychæta, part 1 (plates 50-55).—E. Meyrick, Australian Micro-Lepidoptera.—J. Brazier, a new Ochidium.—New land and freshwater Mollusca from New Guinea.

Second series, vol. i. part 1, with 6 plates (May 25, 1886).—E. P. Ramsay and J. Douglas-Ogilby, descriptions of new Australian fishes; new species of fish from New Guinea; a new Coris from the New Hebrides.—E. P. Ramsay, on a new genus and species of fresh-water tortoise from the Fly River, New Guinea (plates 3-6).—George Masters, catalogue of Australian Coleoptera, part 3.—F. Ratte, *Crioceras australe*, Moore (?), a Lower Cretaceous fossil from Queensland (plates 1, 2).—Wm. Macleay, the insects of the Fly River, New Guinea.—C. W. de Vis, on some Geckos in the Queensland Museum.—A. S. Olliff, on a new Aphanipterous insect from New South Wales.—Wm. A. Haswell, on the myology of *Petaurista taguanoides*.—Capt. F. W. Hutton, the Mollusca of the Pareora and Oamaru systems of New Zealand.

Proceedings of the Royal Society of Queensland, vol. ii. parts 1 and 2, June 1886, contain, among others:—W. E. Armit, notes on the philology of the islands adjacent to the south-eastern extremity of New Guinea (pp. 2-12), and on the Papuans (pp. 78-116).—C. W. De Vis, on the bones and teeth of a large extinct lizard (pp. 25-31, plates 1-3).—On an extinct Ornithorhynchus (pp. 35-40, plate 4).—On some new species of Salarias, and on a new species and genus of lizard (pp. 56-61).—On a fossil Saurian (pp. 181-192, plates 10-15).—Henry Tryon, on Queensland harvesting-ants.—W. A. Tully, short account of the measurement of the base-line in connection with the trigonometrical survey of Queensland.—Baron von Müller, on a new tiliaceous tree (*Elæocarpus Bancroftii*) from North Eastern Australia.

Proceedings of the Royal Society of Tasmania for 1885 (Tasmania, 1886).—From the records of the *Proceedings* it is interesting to learn that, though the Society has lost the exclusive control over the Museum and Gardens, which now are managed by trustees, some of whom are elected by the Society, yet the work of the Society continues to develop, and its library to increase. This volume is accompanied by a sketch-map, coloured, giving the general geological features of Tasmania, by C. P. Sprent and R. M. Johnston; and a geological chart, by Mr. Johnston, showing the proposed provisional classification of the stratified rocks of Tasmania and their equivalents elsewhere.—Among the more important papers we note the following:—R. M. Johnston, various memoirs on the geology and palæontology of Tasmania.—R. A. Bastow, on the mosses and Jungermania of Tasmania.—W. F. Pettard, new Tasmanian marine shells.—Baron F. von Müller, notes on J. J. H. de Labillardière (with a portrait).—Capt. Shortt, earthquake-phenomena in Tasmania.—T. Stevens, on boring for coal in Tasmania.

ON THE OCCURRENCE OF CELLULOSE IN TUBERCULOSIS

CELLULOSE, the principal constituent of the vegetable cell-wall, has been found to occur also in some animals; the mantle of *Phallusia mamillaris* and of Cynthia, and the external coat of Salpa consist mainly of tunicin, or animal cellulose. Now a further very valuable contribution to our knowledge of the occurrence of this body has been made in Vienna by Herr Ernst Freund, working at Prof. E. Ludwig's laboratory. Freund has succeeded in preparing from some of the organs and blood of tuberculous persons a substance exactly resembling cellulose, and showing all the reactions which have hitherto been described as peculiar to the latter. The reactions employed were the following:—(1) Conversion of cellulose when dissolved in concentrated sulphuric acid into dextro e on boiling with dilute sulphuric acid; (2) resistance if treated with Schultze's reagent, a mixture of nitric acid and chlorate of potassium; (3) yielding of a collodion-like mass by the action of nitric acid and ether; (4) assuming a blue colour by the action of iodine in presence of concentrated sulphuric acid or chloride of zinc solution; (5) assuming a violet colour by the action of a naphthol when dissolved in concentrated sulphuric acid (Molisch's reaction); (6) insolubility in common (indifferent) solvents (dilute alkalies); (7) solubility in a solution of cupric hydroxide in ammonia. The substance obtained from miliary tubercles and from the blood of tuberculous persons was subjected to ultimate analysis in three cases, and yielded between 45·12 and 44·70 per cent. C, and between 6·41 and 6·19 per cent. H; while 44·74 per cent. C and 6·17 per cent. H corresponds to $C_6H_{10}O_5$. A quantitative determination of the cellulose of the tubercles has not been made. The researches were carried out on material from twenty-five tuberculous and thirty non-tuberculous cases. The tuberculous material (lungs, spleen, peritoneum with miliary tubercles, blood) embraced cases of conglomerated as well as of infiltrated tuberculosis in the different stages of the disease. The non-tuberculous material examined was taken partly from healthy organs, partly from organs affected by various diseases—as, *e.g.*, from pneumonia, emphysema, pulmonary gangrene—and failed to show any of the reactions described above. Carcinomatous, sarcomatous, lupoid, syphilitic, and other non-tuberculous granulations were also examined with negative results. From his researches Herr Freund makes the suggestion that in tuberculous growths and in the blood of tuberculous persons cellulose forms an intrinsic constituent. We need not refer to the importance and suggestiveness of Freund's discovery for pathological science, making further researches on this subject very desirable.

DISINFECTION BY HEAT

THE Annual Report for 1884 of the Medical Officer of the Local Government Board contained a memoir, by Dr. H. F. Parsons, on the subject of disinfection by heat. Of this memoir the leading points are here given.

In considering the applicability of heat as a means of disinfection, several distinct questions present themselves for solution. It has first of all to be determined what degree of heat and duration of exposure are necessary under different conditions, as of moisture and dryness, in order to destroy with certainty the activity of the contagia of infectious diseases.

We have next to ascertain how the required degree of heat may be made to penetrate through bulky and badly conducting articles, *e.g.* of clothing and bedding, for the disinfection of which the application of heat is especially employed.

We have also to learn whether such articles can be submitted to the required degree of heat without injury, for if not, disinfection presents little advantage over destruction.

After giving a *résumé* of the results of previous experiments to ascertain the degree of heat necessary to destroy the contagia of infectious diseases, from those of Dr. Henry published in the *Philosophical Magazine* for 1831, to those of Koch and his coadjutors (*Mittheilungen aus dem kaiserlichen Gesundheitsamte*, Berlin, 1881), the author states the results of a series of experiments made by him in conjunction with Dr. Klein, who prepared the infective materials, and, after these had been exposed to disinfecting processes, tested the results by inoculation on animals; control inoculations with unheated portions of the same materials being also in all cases made.

The following were the infective materials employed:—

(1) Blood of guinea-pig dead of anthrax, containing bacillus anthracis without spores.

(2) Pure cultivation of bacillus anthracis in rabbit broth, without spores.

(3) Cultivation of bacillus anthracis in gelatine, with spores.

(4) Cultivation of bacillus of swine fever (infectious pneumo-enteritis of the pig) in pork broth.

(5) Tuberculous pus, from an abscess in a guinea-pig which had been inoculated with tubercle.

Infectious pneumo-enteritis of the pig (swine fever) has been shown by Dr. Klein to be caused by the introduction into the body of the affected animal of a specific bacillus. This disease among pigs is highly infectious, the contagium being transmissible from pig to pig through the air, and persisting in infected buildings in a similar manner to the observed behaviour of small-pox and scarlet fever among human beings; and, though not transmissible to mankind, it can be inoculated upon rodents, although in the latter animals it is not contracted by infection received through the air.

The experiments on the disinfecting power of dry heat were mostly made in a copper hot-air bath, or in one improvised of flower-pots, and furnished with a Bunsen's regulator; those with steam were made in a felt-covered tin cylinder, through which passed a stream of steam from a kettle beneath.

The mode of procedure in exposing the materials to heat was as follows:—Strips of clean flannel were steeped in the respective infective fluids, dried in the air, wrapped separately and loosely in a single layer of thin blotting-paper, and suspended in the centre of the apparatus in company with a thermometer, so placed that its bulb was close to the packets of infected material.

The following were the results of the experiments with dry heat:—

Anthrax bacilli without spores were sterilised by exposure for five minutes only to a dry heat varying between 212° and 218° F.

Spore-bearing cultivations of the bacillus anthracis, on the other hand, did not lose their vitality by a two hours' exposure to 220° F., but were sterilised by exposure for four hours to 220° F., or one hour to 245° F.

A rabbit inoculated with swine fever virus which had been exposed to dry heat varying between 212° and 218° F. for an hour remained well; but one inoculated with virus exposed to a similar heat for only five minutes, died of swine fever after nineteen days, the usual time of death after inoculation being between five and eight days.

Guinea-pigs inoculated with tuberculous pus exposed for five minutes to 220° F. remained well.

The foregoing results, as far as regards anthrax, are far more favourable to the efficacy of dry heat as a disinfecting agent than those of Koch. It appears that the spores of the bacillus anthracis lost their vitality, or at any rate their pathogenic quality, after exposure for four hours to a temperature a little over the boiling-point of water, or for one hour to a temperature of 245° F. Non-spore-bearing bacilli of anthrax and of swine fever were rendered inert by exposure for an hour to a temperature of 212°–218°, and even five minutes' exposure to this temperature sufficed to destroy the vitality of the former, and impair that of the latter.

As none of the infectious diseases for the extirpation of which measures of disinfection are in practice commonly required are known to depend upon the presence of bacilli in a spore-bearing condition, it is concluded that, as far as our present knowledge goes, their contagia are not likely to retain their activity after being heated for an hour to 220° F.

In the experiments with steam the results were conclusive as to the destructive power of steam at 212° F. upon all the contagia submitted to its action. In one instance only was there room for suspicion that the disinfection had not been complete: this was in the case of the highly-resisting anthrax spores, exposed to steam for five minutes only: the animal had six days afterwards a swelling at the seat of inoculation, but remained well. On the other hand the animals inoculated with unheated portions of the same materials all died.

These results are in accordance with those of Koch, Gaffky, and Löffler, and it may be considered established that the complete penetration of an object by steam heat for more than five minutes is sufficient for its thorough disinfection.

In view of the above satisfactory results it was not deemed necessary to make any experiments as to the disinfecting power of steam at higher temperatures or under pressure, its efficacy being taken for granted.

Dr. Klein found that boiling in water for only one minute was sufficient to render inert the spores of the bacillus anthracis, although it is known that some of the spore-bearing non-pathogenic bacilli are only destroyed by prolonged boiling, or by a moist temperature above the boiling-point.

Some observations were made on the destruction of lice by heat. It was found that the eggs of lice could be conveniently hatched by tying up tightly in muslin a small piece of the garment on which they were deposited, and carrying it about for a week or two in a warm pocket. Tested in this way no development was found to take place in eggs of lice which had been exposed for one hour to 300° F. dry heat, for one hour to 230° F. dry heat, or for ten minutes to steam at 212° F., or which had been boiled for five minutes in water. The maximum heat which lice or their eggs will bear with impunity was not ascertained.

In order to secure the thorough and certain disinfection by heat of porous articles likely to retain infection, such as clothing and bedding, it is necessary that the heat should be made to permeate the articles in every part to such a degree and for such a length of time as to destroy all infectious matter which they may contain.

It has been remarked that such articles as bedding and blankets are the highest outcomes of the ingenuity of man to check the passage of heat from one side of the object to the other. It is no wonder, therefore, that they should be found difficult of penetration by heat. Even thin layers, however, of badly conducting substances interpose a considerable barrier to the passage of dry heat. The following experiment was made to ascertain how far the inclosing of infective objects in blotting-paper or test-tubes plugged with cotton wool (as in Dr. Koch's experiments) hindered the full access of heat to them.

Two similar registering thermometers were taken: the bulb of one was tied up in a single layer of thin white blotting-paper, that of the other was placed in a test-tube ⅞ inch wide in such a manner as not to touch the sides, and a plug of white cotton wool 1 inch deep was pushed into the tube around the stem of the thermometer, but not as far as the bulb. Both the paper and cotton wool were previously dried. The two thermometers, together with another with bare bulb, were then hung up in a hot-air bath. Heat being applied, the thermometers were read half-hourly as follows:—

Time from lighting	Readings of thermometer with bulb: Bare °F.	In paper °F.	In tube °F.
½ hour ...	162 ...	147 ...	151
1 hour ...	212 ...	193 ...	196
1½ hour ...	234 ...	213 ...	219
2 hours ...	242 ...	236 ...	238
2½ hours ...	244 ...	244 ...	244

The following experiment was made with a thermometer having the bulb covered with a single layer of blanket and placed in the hot-air bath already heated:—

Time from placing in hot-air bath	Thermometer with bulb bare °F.	Thermometer with bulb in blanket °F.
½ hour ...	246 ...	231
1 hour ...	260 ...	250
1½ hour ...	266 ...	254
2 hours ...	268 ...	263
2½ hours ...	268 ...	264

Experiments made with larger articles and apparatus showed how difficult it was to secure the penetration of a dry heat sufficient for disinfection into the interior of such an object as a pillow. It was only effected by employing a high degree of heat, or by continuing the exposure during many hours, length of exposure compensating for a lower degree of heat. On the other hand heat in the form of steam penetrates much more rapidly than dry heat. Thus a thermometer in a roll of dry flannel placed in a hot-air bath at 212° F., at the end of an hour registered only 130° F. In the same roll, placed in the steam cylinder for ten minutes, the thermometer marked 212° F. Experiments on the large scale were equally conclusive. The causes of the superior penetrative power of heat in the form of steam over hot air appear to be:—

(1) The large amount of latent heat in steam, set free on its condensation. In hot dry air, on the other hand, the evaporation of hygroscopic moisture takes up heat and delays the attainment of the required temperature.

(2) Steam, on condensation into water, occupies but a very small fraction of its former volume and thus makes room for more. Hot air in cooling diminishes in volume in much less proportion.

(3) The heat evolved in the moistening of a dry porous substance. In the centre of a highly-dried roll of flannel placed in the cylinder in a current of steam at 212° F., a thermometer, after five minutes' exposure, registered 239° F.

(4) The higher specific heat of steam than of air.
(5) The greater diffusive power of steam than of air.
(6) The effects of pressure. By applying steam under pressure, relaxed and reapplied from time to time, so as to displace the cold air remaining in the interstices of the material, we have a means of considerably increasing the penetrative power of the steam.

In view of the superior efficacy of steam, both in the destruction of infective matters and in the penetration of badly-conducting materials, some experiments were made with moist air in the hope that it might be found possible to obtain the advantages of the use of steam without its drawbacks.

In these experiments either an evaporating vessel containing water was placed at the bottom of the hot-air chamber, or steam evolved in a separate boiler was led into the chamber by a pipe.

An attempt was made to measure the degree of humidity of the air by suspending in the chamber two maximum-registering thermometers arranged side by side, one of them having its bulb covered with gauze kept moist by dipping in a phial of water, as in the wet-and-dry-bulb arrangement employed by meteorologists. It appears, however, that there are no tables or formulæ in existence by which the degree of humidity of the air corresponding to a given difference between the wet and dry bulb thermometers at these high temperatures can be ascertained. The conditions in a heated chamber are so different from those met with in meteorological practice, that it is doubtful whether the relative humidity of the air could be obtained in this way with any great degree of accuracy; but a comparison of the readings of the wet and dry bulb thermometers was found in practice to be useful as a rough indication of the dryness or dampness of the air, although the readings could not be reduced to a common measure.

The experiments seem to show conclusively that moistening the air of the heated chamber diminishes the time necessary for the penetration of heat into a badly-conducting object. As examples the following observations may be quoted. They were made in an iron chamber heated by a furnace underneath, and furnished with a pipe by which steam could be admitted.

		No steam admitted	A small jet of steam admitted	Large jet of steam admitted
Maximum readings of thermometers hung up in chamber ...	Dry bulb	299° F.	... 299° F.	... 249° F.
	Wet bulb	146°	... 165°	... 190°
Temperature attained in centre of similar pillows exposed for one hour in heated chamber		136°	... 188°	... 209°

The moistening of the air of the heated chamber by either method was further found to have the advantage of rendering more equable the distribution of temperature in different parts of the chamber, thus tending to prevent scorching of the articles placed therein.

On the other hand it was not found that the presence of moisture in proportions such as these, or even greater, increased the disinfecting effect at the temperature employed; spores of the bacillus anthracis retained their vitality equally well in heated air whether it were moist or dry; thus they caused the death of a guinea-pig after exposure for an hour to a temperature of {dry bulb 220° F., wet bulb 190° F.} whereas five minutes' exposure to a current of steam at 212° F. was sufficient to render them inert.

To avoid risk of injury to articles subjected to disinfection by heat is an important practical question, not only on account of the value of the articles themselves, but also because, if the exposing of such articles to heat be attended with risk of injury, there is danger lest, to avoid this risk, they may not be sufficiently heated to insure disinfection. The following are the principal modes in which injury may occur; they are somewhat different in the case of steam from that of dry heat:—

1. Scorching or partial decomposition of organic substances by heat. In its incipient stages this manifests itself by changes of colour, changes of texture, and weakening of strength.
2. Overdrying, rendering materials brittle (by dry heat).
3. Fixing of stains, so that they will not wash out.
4. Melting of fusible substances, as wax and varnish, and ignition of matches accidentally left in pockets.
5. Alterations in colour, gloss, &c., of dyed and finished goods.
6. Shrinkage and felting together of woollen materials.
7. Wetting (by steam).

Scorching begins to occur at different temperatures with different materials, white wool being soonest affected. It is especially apt to occur where the heat is in the radiant form. To avoid risk of scorching the heat should not be allowed much to exceed 250° F., and even this temperature is too high for white woollen articles.

By a heat of 212° and upwards, whether dry or moist, many kinds of stains are fixed in fabrics so that they will not wash out. This is a serious obstacle in the way of the employment of heat for the disinfection previous to washing of linen, &c., soiled by the discharges of the sick.

Steam disinfection is inapplicable in the case of leather, or of articles that will not bear wetting. It causes a certain amount of shrinkage in textile materials, about as much as an ordinary washing. The wetting effect of the steam may be diminished by surrounding the chamber with a jacket containing steam at a higher pressure, so as to superheat the steam in the chamber.

For articles that will stand it, washing in boiling water (with due precautions against re-infection) may be relied on as an efficient means of disinfection. It is necessary, however, that before boiling the grosser dirt should be removed by a preliminary soaking in cold water. This should be done before the linen leaves the infected place.

The objects for which disinfection by dry heat or steam is especially applicable are such as will not bear boiling in water, *e.g.*, bedding, blankets, carpets, and cloth clothes generally.

Apparatus for disinfection by heat may be classified as follows:—

(a) *By hot air*—

1. Apparatus in which the heat is applied to the outside o the chamber, and the products of combustion do not enter the interior.
2. Apparatus in which the heated products of combustion enter the interior.
3. Apparatus heated by steam or hot water circulating in closed pipes.
4. Apparatus in which air previously heated is blown into the chamber.

(b) *By steam*—

5. By a current of free steam.
6. By steam confined in a chamber at pressures above that of the atmosphere.

The most important requisites of a good apparatus for disinfection by heat are (*a*) that the temperature in the interior shall be uniformly distributed; (*b*) that it shall be capable of being maintained constant for the time during which the operation extends; and (*c*) that there shall be some trustworthy indication of the actual temperature of the interior at any given moment. Unless these conditions be fulfilled, there is risk, on the one hand, that articles exposed to heat may be scorched, or on the other hand, that through anxiety to avoid such an accident the opposite error may be incurred, and that the articles may not be sufficiently heated to insure their disinfection.

In dry-heat chambers the requirement (*a*) is often very far from being fulfilled, the temperature in different parts of the chamber varying sometimes by as much as 100°. This is especially the case in apparatus heated by the direct application of heat to the floor or sides of the chamber. The distribution of temperature is more uniform in proportion as the source of heat is removed from the chamber, so that the latter is heated by currents of hot air rather than by radiation.

There is a marked difference between the distribution of temperature in a chamber heated primarily by radiant heat and in one heated by the admission of hot air or steam. Radiant heat is most intense close to its source, diminishing rapidly as we recede therefrom. Also it does not turn corners, and thus objects lying behind others are screened from it, except so far as it may be reflected upon them from other surfaces. The rays strike the walls of the chamber and objects therein, so that these are more highly heated than the air, which becomes heated only secondarily by contact with them.

On the other hand, if air already heated, or steam, be admitted into a chamber, the temperature tends to equalise itself in the different parts, and the walls and solid contents of the chamber do not become hotter than the air.

In chambers heated by gas, when once the required temperature has been attained, but little attention is necessary to maintain it uniform, and in the best-made apparatus this is automatically performed by a thermo-regulator. On the other hand, in apparatus heated by coal or coke the temperature continually tends to vary, and can only be maintained uniform by constant attention on the part of the stoker.

In very few hot-air chambers did the thermometer with which the apparatus was provided afford a trustworthy indication of the temperature of the interior; in some instances there was an error of as much as 100° F. This is due to the thermometer, for reasons of safety and accessibility, being placed in the coolest part of the chamber, and to the bulb being inclosed for protection in a metal tube which screens it from the full access of heat. The difficulty may be overcome by using, instead of a thermometer, a pyrometer actuated by a metal rod extending across the interior of the chamber.

In steam apparatus the three requirements above mentioned are all satisfactorily met, and for this reason, as well as on account of the greater rapidity and certainty of action of steam, both in penetrating badly conductive materials and in destroying contagia, steam chambers are, in Dr. Parsons's opinion, greatly preferable to those in which dry heat is employed.

It is important that the arrangements of the apparatus, the method of working, and the mode of conveyance to and fro, should be such as to obviate risk of articles which have been submitted to disinfection coming into contact with others which are infected.

The latter part of the Report is taken up with descriptions of the various forms of apparatus in use for disinfection by heat, and accounts of experiments made with a view to test their practical efficiency.

ON THE FRACTIONATION OF YTTRIA[1]

HAVING already explained the methods of chemical fractionation, it may be useful now to describe some of the results yielded by an extended perseverance in these operations.

I must, in the first place, explain that my work has been confined to a limited and very rare group of bodies—the earthy bases contained in such minerals as samarskite, gadolinite, &c. These have been repeatedly put through the fractionation mill by other chemists, but the results have been most unsatisfactory and contradictory, no sufficiently good test being known whereby the singleness of any earth got out by fractionation could be decided, except the somewhat untrustworthy one of the atomic weight. I say *untrustworthy*, because it is now known that fractionation, unless it is pushed far beyond the point to which some Continental chemists have even carried it, is quite as liable to give *mixtures* which refuse to split up under further treatment of the same kind, as it is to yield a chemically simple body. This I have fully gone into in my paper "On the Methods of Chemical Fractionation." The unsatisfactory nature of fractionation work may be seen from expressions used, in private letters to me, by some of the eminent chemists who have almost made this method their own. One writes—"It is very tiresome working with the rare earths, as we never can be sure when we have got a definite result. There will never be an end to their history. I am very tired of it, and am much inclined to give it up." Another writes—"Unfortunately I commenced my researches on the rare earths with too little material, and I have not had the courage, at my age, to recommence the work on more abundant material. The further I advance in my work the more I am convinced that no known method permits of the complete separation of these different earths one from the other." A third writes—"One loses so much material in the separations that it appears to me scarcely possible, with the material available, to arrive at a successful solution of the question." I could multiply similar quotations, all breathing the same almost despairing spirit.

It would certainly not have been prudent on my part to invite a time-honoured comparison, and "rush in" where so many eminent men "fear to tread," were it not that good fortune had placed in my hands a physical test for these obscure molecular groupings which is of the most exquisite sensitiveness. I refer to what I have for shortness called the Radiant-Matter test.

It is well known that a limited group of these rare earths, when phosphoresced *in vacuo*, yield discontinuous spectra. The method adopted to bring out the spectra is to treat the substance under examination with strong sulphuric acid, drive off excess of acid by heat, and finally to raise the temperature to dull redness. It is then put into a radiant-matter tube of the form shown in Fig. 1, and the induction spark is passed through it after the exhaustion has been pushed to the required degree. The phosphorescence occurs beneath the negative pole. As each gaseous molecule, carrying its charge of negative electricity with it, strikes the earthy sulphate, it has a tendency to part with its charge, provided it finds a body ready to take up the electricity; otherwise it retains its charge. Bodies like yttrium sulphate, &c., easily take the electric charge, and under the stimulus phosphoresce, emitting light whose waves tend to collect round definite centres of length. The phosphorescent light which the discharge evokes is best seen in a spectroscope of low dispersion, and with not too narrow a slit. In appearance the bands are more analogous to the absorption-bands seen in solutions of didymium than to the lines given by spark spectra. Examined with a high magnifying power, all appearance of sharpness generally disappears: the scale measurements must therefore be looked upon as approximate only; the centre of each band may be taken as accurately determined within the unavoidable errors of experiment, but it is impossible to define their edges with much precision. The bands are seen much sharper when the current first passes than after the current has been passing for some time and the earth has become hot. On cooling, the sharpness of the bands re-appears.

As a general rule, the purer the earth the sharper the band, and when impurities are removed to the utmost extent, the sharpness is such as to deserve the name of a line. This may be illustrated by mixing together yttria and lime. Lime phosphoresces with a continuous and yttria with a discontinuous spectrum. Mixed together, the phosphorescing energy of the lime does not spend itself over the whole spectrum, but concentrates itself in greatly reinforcing the yttria bands. A molecule of yttria vibrating with a definite wave-length gives a nearly sharp line, but the molecule of lime with which it is weighted has no special tendency to vibrate to one wave-length more than another. The yttria induces the right vibration in the adjacent molecule of lime; but this lime, once set in vibration, cannot confine itself to the exact wave-length required, and overflows a little on each side, and the result is a widening and blurring of the bands, becoming greater in amount as the extraneous earth increases in quantity.

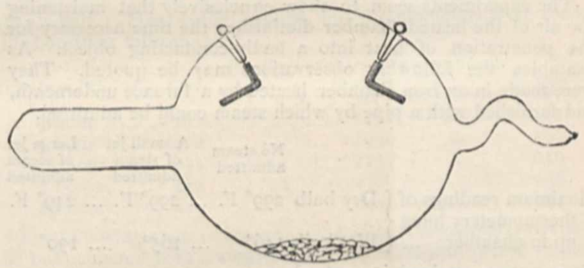


FIG. 1.

To this rule one exception occurs. The body which I have named Sδ, or 609, is remarkable for the great sharpness of its phosphorescent line, and I have noticed scarcely any variation in its sharpness, however large the bulk of extraneous earth associated with it. This line, however, is sharper and brighter when the current is first turned on than it is after the earth has been phosphorescing for a minute or so.

In the Bakerian lecture on yttrium delivered before the Royal Society (*Phil. Trans.* Part 3, 1883), I described the phosphorescent spectrum given by this element, and in the address which I have had the honour of delivering before this Section I gave a drawing of the spectrum of yttrium, together with a sketch of the train of reasoning by which I had been led to the opinion that excessive and systematic fractionation had split up this stable molecular group into its components, distributing its atoms into several groups, with different phosphorescent spectra.

No longer than twelve months ago the name yttria conveyed a perfectly definite meaning to all chemists. It meant the oxide of the elementary body yttrium. I have in my possession specimens of yttria from M. de Marignac (considered by him to be purer than any chemist had hitherto obtained), from M. Clève (called by him "purissimum"), from M. de Boisbaudran (a sample of which is described by this eminent chemist as "scarcely

[1] A Paper read before Section B of the British Association at the Birmingham meeting, by William Crookes, F.R.S., V.P.C.S

soiled by traces of other earths"), and also many specimens prepared by myself at different times and purifiel up to the highest degree known at the time of preparation. Practically these earths are all the same thing, and up to a year ago every living chemist would have described them as identical, *i.e.* as the oxide of the element yttrium. They are almost indistinguishable one from the other both physically and chemically, and they give the phosphorescent spectra *in vacuo* with extraordinary brilliancy. This is what I formerly called yttria, and have more recently called *old* yttria Now these constituents of old yttrium are not *impurities* in yttrium any more than praseodymium and neodymium (assuming them really to be elementary) would be impurities in didymium. They constitute a veritable splitting up of the yttrium molecule into its constituents.

The plan adopted in the fractionation of yttria does not differ in principle from the methods described in my former paper "On the Methods of Chemical Fractionation." Dilute ammonia is added to a very dilute solution of the earth in only sufficient quantity to precipitate one half. After standing for several hours the precipitate is filtered. After each fractioning the filtrate is passed to the left and the precipitate to the right, and the operations are continued many thousand times.

The diagram (Fig. 2) shows the scheme clearly, with the direction the precipitates and solutions travel. Limited space, even on a large diagram, prevents me from giving more than a few operations, but they will be sufficient to satisfy you that enormous patience, a large amount of material, and a not insignificant number of bottles, are requisites for successful fractionation. Such proceedings are tedious enough even in their narration, but no mere words can enable any one to realise the wearisome character of these operations when repeated day by day, month after month, on long rows of Winchester quart bottles.

After a certain time, on examining the series of earths in the lowest line of bottles, their phosphorescent spectra are found to alter in the relative intensities of some of the lines, and ultimately different portions of the fractionated earths show spectra such as I have endeavoured to illustrate at the foot of the diagram (Fig. 2), where I give the spectra of five components of yttrium.

The final result to which I have come is that there are certainly five, and probably eight, constituents into which yttrium may be split. Taking the constituents in order of approximate basicity (the chemical analogue of refrangibility), the lowest earthy constituent gives a deep blue band, Gα (λ 482); then there is a strong citron band, Gδ (λ 574), which has increased in sharpness

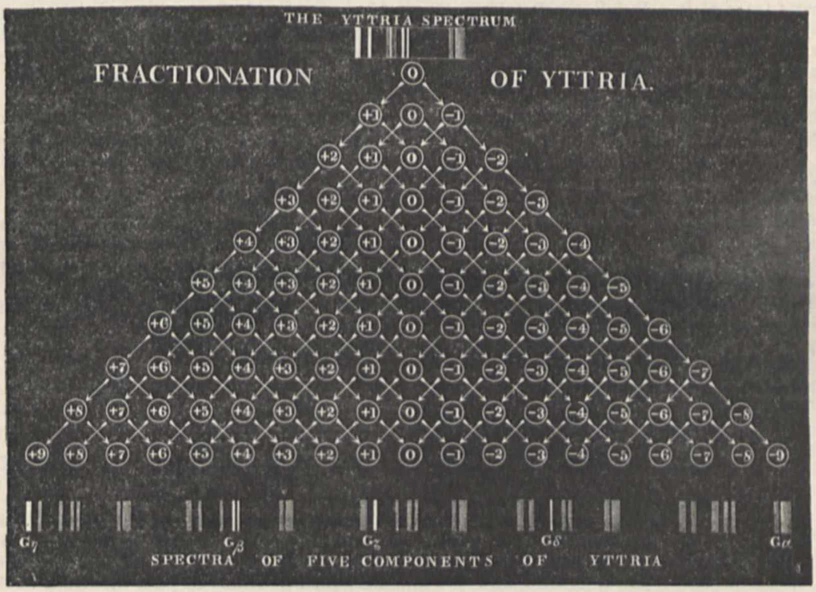


FIG. 2.

till it deserves to be called a line; then come a close pair of greenish-blue lines, Gβ (λ 549 and λ 541, mean 545); then a red band, Gζ (λ 619), then a deep red band, Gη (λ 647), next a yellow band, Gε (λ 597), then another green band, Gγ (λ 564); this (in samarskite and cerite yttria) is followed by the orange line Sδ (λ 609). The samarium bands remain at the highest part of the series. These, I am satisfied, are also separable, although for the present I have scarcely touched them, having my hands fully occupied with the more easily resolvable earths. The yellow band, Gε, and green band, Gγ, may in fact be due to a splitting up of samarium.

Until we know more about these bodies I refrain from naming them, but will designate them provisionally by the mean wave-length of the dominant band. If, however, for the sake of easier discussion among chemists a definite name is thought to be more convenient, I will follow the plan frequently adopted in such cases, and provisionally name these bodies as shown in the table given below.

The initial letters S and G recall the origin of the earths respectively from Samarskite and Gadolinite.

Not only has yttrium been split up by subjection to fractionation, but samarium, as I have hinted above, is likely to prove equally unable to resist this operation. In the phosphorescent spectrum of samarium sulphate the line Sδ (609) is one of the constituents. When yttria is added to samaria this line is developed in greater intensity, as yttria has the power of deadening the other bands of samarium, while it does not seem to affect the

Position of lines in the spectrum	Scale of spectroscope	Mean wave-length of line or band	$\frac{1}{\lambda^2}$	Provisional name	Probability
Bright lines in—					
Deep blue ...	8·931	482	4304	Gα	New
Greenish-blue (mean of a close pair...)	9·650	545	3367	Gβ	New, or the Zβ of M. de Boisbaudran
Green....... ..	9·812	564	3144	Gγ	New
Citron	9·890	574	3035	Gδ	New, or the Zα of M. de Boisbaudran
Yellow.........	10·050	597	2806	Gε	New
Orange.........	10·129	609	2693	Sδ	New
Red............	10·185	619	2611	Gζ	New
Deep red......	10·338	647	2389	Gη	New

line Sδ. Several circumstances, however, tend to show that although line Sδ accompanies samarium with the utmost pertinacity, it is not so integral a part of its spectrum as the other red, green, and orange lines. For instance, the chemical as well as physical behaviour of these line-forming bodies is different. On closely comparing the spectra of specimens of samaria from different sources, line Sδ varies much in intensity, in some cases being strong and in others almost absent; the addition of yttria is found greatly to deaden the red, orange, and green lines of samarium, while yttria has little or no effect on the line Sδ; again, a little lime entirely suppresses line Sδ, while it brings out the samarium lines with increased vigour. Finally, attempts to separate line Sδ from samarium and those portions of the samarskite earths in which it chiefly concentrates has resulted in sufficient success to show me that, given time enough, and an almost inexhaustible supply of material, a separation would not be difficult. These facts, together with the peculiar behaviour of the lines Gε and Gγ, strengthen my suspicion as to the resolvability of samarium.

Samaria giving the line Sδ had been prepared from cerite and samarskite. Many observations had led me to think that the proportion of band-forming constituents varied slightly in the same earth from different minerals. Amongst others, gadolinite showed indications of such a differentiation, and therefore I continued the work on this mineral. Very few fractionations were necessary to show that the body giving line Sδ was not present in the gadolinite earths; no admixture of yttria and samaria from this source giving a trace of it. It follows, therefore, that the body whose phosphorescent spectrum gives line Sδ occurs in samarskite and cerite, but not in gadolinite.

It now became an interesting inquiry whether all these constituents of yttrium were united together in exactly the same proportion in every case. A glance at the diagram will show that yttrias from different sources, although they may be alike as far as our coarser chemical tests are concerned, are not built up exactly in the same manner. Thus, when the samarskite yttrium was forming, all the constituent molecules—which I have provisionally named Gα, Gβ, Gγ, Gδ, Gε, Gζ, Gη, and Sδ—condensed together in fair proportion. In gadolinite yttrium the constituents Gβ and Gδ are plentiful, Gζ is very deficient, Sδ is absent, and the others occur in moderate quantities. In the yttrium from xenotime Gδ is most plentiful, Gβ occurs in smaller proportion, Gζ is all but absent, and Sδ is quite absent. Yttrium from monazite contains Gβ and Gδ, with a fair proportion of the other constituents, Gβ is plentiful and the red is good. Yttrium from fluocerite is very similar to that from monazite, but Gα is weaker. Yttrium from hielmite is very rich in Gδ, has a fair quantity of Gα and Gβ, less of Gγ, no Sδ, and only a very faint trace of Gη. Yttrium from euxenite is almost identical with that from hielmite. Yttrium from cerite contains most Gζ and Gδ, less Gα and Gβ, only a trace of Gη, and a fair proportion of Sδ.

I have already mentioned how the key to these explanations was gained by an examination of the phosphorescent spectrum of M. de Marignac's Yα (now called by him gadolinium).

Referring to the diagram, it is seen that Yα is composed of the following band-forming bodies:—Gβ, Sδ, Gζ, together with a little samarium. Calling the samarium an impurity, it is thus seen that gadolinium is composed of at least three simpler bodies.

It is by a method of his own, differing from mine, that M. de Boisbaudran has obtained phosphorescent spectra of some of the rare earths. He takes the induction-spark between the surface of a strong and acid solution of the metallic chloride and a clean platinum wire a few millims. above it. The platinum wire is kept negative and the solution positive; it is then observed that in many cases a thin layer of fluorescent light is seen at the surface of the liquid. This layer gives a spectrum of nebulous bands. For the sake of brevity I will adopt M. de Boisbaudran's term, and call this process the *method of reversion* (the direction of the spark being reversed). As this method is entirely different to the one I adopt, it is not surprising that the results are also different. Experimenting in this way M. de Boisbaudran has obtained, among others, two bands (λ 573 and λ 543·2), which he considers are caused by two elements, named respectively Zα and Zβ, and which he considers new, at all events if we except terbium and possibly the elements of what was formerly called holmium. His method fails to show any spectrum in solutions of yttria which by my method give the yttria bands with the greatest brilliancy; while conversely his method shows a fluorescent spectrum in solutions of earths separated as widely as possible from yttria, chemically as well as spectroscopically. My experiments on both these methods tend to the conclusion that our bands are not due to the same cause, although M. de Boisbaudran's experiments have led him to the opposite conclusion. The band of Zβ (543) falls between the double green band Gβ, and the band of Zα (573) would come very near the citron line Gδ.

In the hands of a practised experimentalist like M. de Boisbaudran this method may give trustworthy indications, but I must confess that in my opinion the test is one beyond the range of practical analysis, owing to the enormous difficulty of getting the phenomena described by the discoverer. Unless the strength of spark, the concentration and acidity of solution, and the dispersion and magnifying power of the spectroscope bear a certain ratio one to the other, the observer is likely to fail in seeing a spectrum even in solutions of earths which contain considerable quantities of Zα and Zβ. In my own case I not only have had the advantage of personal instruction in Paris from M. de Boisbaudran himself in the best method of getting these reversion spectra, but on returning to London I brought with me some of the identical earths which give these spectra at their best. In spite of these advantages I have sometimes experimented off and on for weeks without being able to see more than a feeble glimmer of the bands described by M. de Boisbaudran.

Again, when everything is most favourable and the reversion bands are at their strongest, they are but a faint and hazy shadow of the brilliant lines given by the bombardment process. M. de Boisbaudran, speaking of the relative sensitiveness of our two methods, says that the bombardment process *in vacuo* is incomparably more delicate than his reversion test, and I estimate the relative sensitiveness of the two methods to be in the proportion of about 1 to 100.

You have probably anticipated in your minds a question which is likely to occur at this point of the inquiry. If such results have been obtained by submitting yttrium to this novel method of analysis, what will be the result of fractionating some other reputed element?

Yttrium, as I have explained, is an exceedingly stable molecular group, capable of acting as an element, just as calcium, for instance, acts as an element: to split up yttrium requires not only enormous time and material, but the existence of a test by means of which the constituents of yttrium are capable of recognition. Had we tests as delicate for the constituent molecular groups of calcium, this also might be resolved into simpler groupings. It is one thing, however, to find out means of separating bodies which we know to be distinct and have colour or spectrum reactions to guide us at every step; it is quite another thing to separate colourless bodies which are almost identical both in chemical reaction and atomic weight, especially if we have no suspicion that the body we are dealing with is a mixture.

(I mention calcium because it is one of several other elements which I have put through the fractionation mill. Many hundred operations have given me just sufficient encouragement to make me wish I had time to push this work to the end.)

One of the chief difficulties in the successful carrying out of an investigation in radiant-matter spectroscopy is the extraordinary delicacy of the test. This extreme sensitiveness is a drawback rather than a help. To the inexperienced eye 1 part of yttrium in 10,000 gives as good an indication as 1 part in 10, and by far the greater part of the chemical work undertaken in my hunt for spectrum-forming elements was performed upon material which later knowledge shows did not contain sufficient to respond to any known chemical test. It is as if the element sodium were to occur in ponderable quantity only in a few rare minerals seldom seen out of the collector's cabinet. With only the yellow line to guide, and seeing the brilliancy with which an imponderable trace of sodium in a mineral declares its presence in the spectrum, I venture to think that a chemist would have about as stiff a hunt before he caught his yellow line as I have had to bring my orange and citron bands to earth.

Chemistry, except in few instances, as water-analysis and the detection of poisons, where necessity has stimulated minute research, takes little account of "traces," and when an analysis adds up to 99·999, the odd 0·001 per cent. is conveniently put down to "impurities," "loss," or "errors of analysis." When, however, the 99·999 per cent. constitutes the impurity, and this exiguous 0·001 is the precious material to be extracted, and when, moreover, its chemistry is absolutely unknown, the difficulties of the problem become enormously enhanced. Insolubility as ordinarily understood is a fiction, and separation by precipitants is nearly impossible. A new chemistry has to be slowly built up, taking for data uncertain and deceptive indications, marred by the interfering power of mass in withdrawing soluble salts from a solution, and the solubility of nearly all precipitates when present in traces in water or in ammoniacal salts. What is here meant by "traces" will be better understood if I give an instance. After fifteen months' work I obtained the earth yttria in a state which most chemists would call absolutely pure, for it contained not more than 1 part of impurity (samaria) in 250,000 parts of yttria. But this one part in a quarter of a million profoundly altered the character of yttria from a radiant-matter-spectroscopic point of view, and the persistence of this very minute quantity of interfering impurity entailed another ten months' extra labour to eliminate these final "traces," and to ascertain the real reaction of yttria pure and simple.

The radiant-matter test applied to these phosphorescing bodies proves itself to be every day more and more valuable, and one of the most far-searching and trustworthy tools ever placed in the hands of the experimental chemist. It is an exquisitely delicate test, capable of being applied to bodies which have been approximately separated, but not yet completely isolated, by chemical means; its delicacy is unsurpassed even in the region of spectrum analysis; its economy is great, inasmuch as the test involves no destruction of material; and its convenience is such that any given specimen is always available for future reference. Likewise, the quantity of material is limited solely by the power of the human eye to see the body under examination. Beyond all these excellences is its trustworthiness. I should perhaps exceed the legitimate inference from experience were I to claim that this test is infallible; but this I may say—during the five years in which the test has been in daily use in my laboratory, I never once have been led to view its indications with suspicion. Anomalies and apparent contradictions have cropped up in plenty; but a little more experiment has always shown that the anomalies were but finger-posts pointing to fresh paths of discovery, and the contradictions were due to my own erroneous interpretation of the facts before me.

SCIENTIFIC SERIALS

Rendiconti del Reale Istituto Lombardo, July.—On some new substituted derivatives of benzine, by E. G. Körner. In order to complete the still defective aromatic series, the author has prepared a number of these derivatives, studying them in connection with the relative isomerous compounds. The list includes a hydrochlorate, $(B)HCl, H_2O$; a sulphate, $(B)2H_2SO_4$; orthoiodacetanilide, $C_6H_4I \cdot NHC_2H_3O$; and nitro-orthobiiodo-benzine, probably $C_6H_2 \cdot I \cdot I \cdot H \cdot NO_2$.—On the effects of the sulphate of copper against the parasites of the grape-vine, by Prof. Gaetano Cantani. It is shown that this remedy, which has already been successfully tried in France, should also be introduced in Italy, if not to supersede, at least jointly with, the milk of lime.—Chemical and experimental researches on human milk, by Prof. G. Sormani and T. Gigli. It appears from the authors' experiments that a mixed or normal diet yields far better results than an exclusively animal or vegetarian *régime*.—Meteorological observations made at the Brera Observatory, Milan, during the month of July.

Botanische Jahrbücher, von A. Engler, Siebenter Band, Heft iv.—Contributions to the morphology and classification of the Cyperaceæ, by Dr. F. Pax. The author regards the Cyperaceæ as reduced types of a series which is more advanced phylogenetically than the Juncaceæ. As regards their relations to the Gramineæ, he concludes that the affinity is not so direct that the one family could be derived from the other.—On the flower and inflorescence of the Centrolepidaceæ, by Prof. Dr. G. Hieronymus.—Contributions to the flora of the Cameroons, by A. Engler. A list of plants collected by Dr. Buchholz in the Cameroons in 1874, with descriptions of the new species.—On the origin of the weeds on arable land and waste places in Germany, part 1, by F. Hellwig.—Abstracts of important papers.

Heft v. opens with part 2 of the above paper by Dr. Hellwig. The first part is chiefly occupied with the general consideration of the subject, and lists of the plants in question; while the second contains a detailed account of the origin of the plants named in the foregoing lists.—The orchids collected by Dr. Naumann on the expedition of H.M.S. *Gazelle*, by F. Kränzlin. The volume closes with a valuable list of works published during 1885, on classificatory botany, &c. This, together with the frequent analyses of the more important of those papers which are published in languages not usually familiar to ordinary readers, greatly enhances the value of Dr. Engler's excellent serial.

Bericht über die Thätigkeit der botanischen Section der Schlesischen Gesellschaft, 1885, compiled by Prof. Dr. F. Cohn.—The Botanical Section of the Society held nine meetings during the year 1885, at which the following original papers were read:—Dr. Engler, on the vegetation of the German possessions in South Africa.—Dr. Pax, on the genus Acer.—Herr Limpricht, on the formation of pores in the cortex of the Sphagna.—Dr. Eidam, on an Entomophthoraceous fungus found on frogs' dung.—Dr. Schröter, on the mycological results of a journey to Norway.—Dr. Pax, on the morphology and classification of the Cyperaceæ.—Dr. Engler, on the family of the Typhaceæ.—The report closes with a statement of the results of the investigation of the Phanerogamic flora of the district in 1885, arranged by R. von Uechtritz.

Beiträge zur Biologie der Pflanzen, von Dr. F. Cohn, Vierter Band, Zweites Heft.—Investigations on the tendrils of the *Cucurbitaceæ*, by Dr. Otto Müller, of Breslau (3 plates). The author concludes, chiefly on anatomical grounds, that the irritable part of the tendril of the Cucurbitaceæ is of foliar nature.—Investigations of the *Flagellatæ*, by Dr. Arthur Seligo (1 plate).—*Basidiobolus*, a new genus of the *Entomophthoraceæ*, by Dr. Ed. Eidam (4 plates). The author regards the resting spores of this genus as true zygospores, though the gametes are of unequal size, and expresses the opinion that the *Entomophthoreæ* find their natural place in the *Zygomycetes*, as directly related to the *Mucorini*.

SOCIETIES AND ACADEMIES

SYDNEY

Royal Society of New South Wales, August 4.—Ch. Rolleston, President, in the chair.—The Society's Medal and Prize of 25*l.* was presented to Mr. S. Herbert Cox, F.C.S., F.G.S., for his prize essay on "The Tin Deposits of New South Wales." The principal deposits occur in New England as impregnations, segregation veins, and lodes in granite, also as gash veins in Silurian slates, and as a network of veins or stockwork in haplite. The granitic eruption occurred not later than Carboniferous times, and no sedimentary strata appear to have been deposited until the Tertiary period, when the leads of alluvial tin were formed, together with their associated gravels. Denudation on an enormous scale has gone on, and the Silurian slates which rest on the granites have only been preserved as outlying patches included in folds in the granite. Dykes of feldspar and quartz porphyry traverse both the granite and slates, but the date of this eruption is probably Tertiary, although evidence appears to point out that this acidic only preceded the ensuing basaltic eruption by a short time. The more fluid basalt flowed for considerable distances, frequently burying the gravels of the river-beds with the tin they contained, and preserving these "deep leads" from subsequent denudation. True lodes appear to be rare, but some remarkable impregnated areas exist in greisen; "segregation" veins of small size are found in the granite, and in the slate "gash" veins up to 4 inches in width occur, but these are certainly not true lodes. Fortunately, wolfram occurs in separate veins from the tin; copper and iron pyrites, fluor-spar, tourmaline, white mica, and topaz are common; beryl forms a rock with quartz, through which tinstone is impregnated. In the alluvial deposits, tinstone is found associated with diamonds, sapphires, zircons, &c. The greater quantity of the tinstone hitherto raised has been from the alluvial, and the "deep leads" which are still being worked, and will probably be greatly developed in the future, closely correspond in their course with the shallow ones. They are worked to depths of 140 to 180 feet, and are frequently found below solid floes of basalt. Very good crushing and smelting plants have been erected, and although the conditions of the district vary greatly in different parts, it may be taken as certain that a yield of 5 per cent. tin in lodes, and from ½ to 1 cwt. per cubic yard in deep alluvial deposits, pays for extraction. The total output of tin between 1872 and 1883 is 64 794 tons of ingots and 13·268 tons of black tin.—A paper by the late Rev. P.

MacPherson, M.A., was also read, on the aboriginal names of rivers in Australia philologically examined.

Paris

Academy of Sciences, October 27.—M. Jurien de la Gravière, President, in the chair.—On Dr. Spœrer's views regarding the solar spots and protuberances, by M. Faye. In a paper recently contributed to the *Proceedings* of the German Astronomical Society, M. Spœrer adopts the view that the faculæ and spots are due to the currents of hydrogen which forms the solar chromosphere. But to the ascending currents, the cause of which is unexplained, is attributed a descending current which, by penetrating amid the faculæ to the body of the sun, gives rise to a spot. The hydrogen thus drawn in reascends round about the funnel of the spot, and, by mingling with the ascending currents, effects a complete circulation. The author points out that these ideas are completely analogous to his own, and would be identical, had M. Spœrer studied the mechanical cause of this remarkable circulation, which is here attributed to the irregular velocities of the horizontal currents producing on the solar surface gyratory movements with a vertical descending axis like those of the terrestrial streams and atmosphere.—A comparative study of the actions of walking and running, together with the mechanism of the transition between these two movements, by MM. Marey and Demeny. In this paper, which complements the author's previous communications on animal kinematics, numerous differences are shown to exist between slow and rapid pace, the latter being characterised by moments of complete detachment from the ground and by other equally important features scarcely visible to the naked eye, but which are now clearly revealed by the chronophotographic and dynamographic processes. The paper is furnished with six diagrams illustrating the contrasts between both motions and the transitions from one to the other.—Considerations on the nervous system of the gastropods, by M. H. de Lacaze-Duthiers. In supplement to previous papers on several aberrant types of gasteropods, the author here continues his analysis of the facts connected with the central nervous system of these organisms. Special care is taken to distinguish between the groups of ganglia of primary importance from others which, notwithstanding their size and numbers, really play only a secondary part in the nervous system of the gasteropods.—Wheat culture at Wardrecques, Pas-de-Calais, and at Blasinghem, Department du Nord, in 1886, by MM. Porion and Dehérain. In continuation of previous reports of the results of experiments carried on for many years in the north-west of France, the authors here announced that the most profitable varieties of wheat are those which, besides yielding the largest returns, are best able to support strong manures without lodging. Preference above all is given to the square-eared variety (*blé à épi carré*), which they hope may be brought into general use in order to meet the growing competition of foreign growers.—Observations of Finlay's comet made at the Lyons Observatory (Brunner equatorial 0·16m.), by M. Gonnessiat.—Observations of the same comet made at the Observatory of Nice (Gautier equatorial), by M. Perrotin.—Note on the errors of division in Gambey's mural circle, by M. Périgaud. These errors being once clearly determined, the author considers that the Gambey circle with the new mercury bath allowing a continuous observation of the Nadir, may be advantageously used in astronomic researches where great precision is required.—On a question concerning the single points of plane algebraic curves, by M. E. B. Guccia.—On the glycerinate of soda, by M. de Forcrand. In this paper the author completes the study of the glycerinate of soda, begun by E. Letts in 1872, and subsequently prosecuted by M. Berthelot.—On the preparation of the sulphur of calcium with violet phosphorescences, by M. A. Verneuil. By the application of the principles laid down by M. E. Becquerel in his researches on phosphorescence, the author has succeeded in effecting the synthesis of this substance, which has been long known in commerce, but the preparation of which had hitherto remained a secret.—On the comparative volatility of the methylic compounds in the various families of the negative elements, by M. Louis Henry. In this paper the author restricts his inquiries to the monocarbonic derivatives, and more especially to the methylic derivatives. He finds that, at equal atomic weight, the diminution of volatility determined in methane by the substitution of a negative element for hydrogen, is all the greater the more this element is removed from hydrogen.—Law determining the position of the embryo in insects, by M. Paul Hallez. From his studies of *Hydrophilus piceus* and *Locusta viridissima*, the author arrives at a general law applicable to insects and probably also to other classes, which he thus formulates:—The cellule ovum is disposed in the same direction as the maternal organism, with a cephalic and a caudal pole, a right and a left side, a dorsal and ventral face coinciding with the corresponding faces of the embryo.—Contributions to the natural history of the Orthonectidæ, by M. R. Kœhler. During his researches on *Amphiura squamata* at the Zoological Laboratory at Cette, the author has found on these animals both male and female of the curious parasite, Rhopalura, already studied by Giard and Julin.—On the exhalations of carbonic acid in infectious diseases determined by aërial and non-aërial microbes, by M. S. Arloing.—Geological constitution of the district of Croix-Rousse (Lyons), by M. Fontannes. The tunnel 2400 metres long now in progress under the terrace between the Rhone and the Saone at Lyons has afforded an opportunity of studying the geological features of the district, which appears to consist mainly of Pliocene sands overlying gneiss with remains of *Mastodon arvenensis*, above which follow Pliocene alluvia with *Elephas meridionalis*, Quaternary alluvia, and Glacial deposits (moraines, loam, &c.).

BOOKS AND PAMPHLETS RECEIVED

"Food-Grains of India," by A. H. Church (Chapman and Hall).—"Electricity in the Service of Man," by Wormell and Perry (Cassells).—"Handbook of Acoustics," by T. F. Harris (Curwen).—"Beobachtungen der Russischen Polarstation an der Lenamündung," ii. Theil. Meteorologische Beobachtungen, by A. Eigner.—"Geometrical Drawing for Army Candidates," by H. T. Lilley (Cassells).—"The Gas Engine," by D. Clerk (Longmans).—"General Biology," by W. T. Sedgwick and E. B. Wilson (Holt and Co., New York).—"The Encyclopædic Dictionary," vol. v. part ii. (Cassells).—"Loisette's Art of Never Forgetting Compared with Mnemonics," by F. Appleby.—"Modern Petrography," by G. H. Williams (Heath and Co., New York).

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