THURSDAY, JUNE 27, 1872

THE TIDES AND THE TREASURY

OUR readers may have heard that England is a "sea-girt isle," and that we are a maritime nation, possessing a very powerful navy and an extensive commerce. They also know that the ocean to which we owe these peculiarities is a very restless fluid, its surface being ruffled by the wind, and its entire mass uplifted and depressed from time to time, in what we call tides, by the attractive power of the sun and moon. They know, too, that the theory of the tides has been investigated by the most profound mathematicians, particularly by Laplace, Lubbock, Airy, and Whewell. And they are, no doubt, aware that the theoretical laws deduced by these learned men, though indispensable as a foundation of our knowledge, are entirely insufficient, by themselves, for the wants of man, the conformation of the coast-line and of the sea bottom powerfully modifying tidal facts. Hence it becomes necessary to resort to observations and surveys in order to know what will be the course of the tides as to heights and times in particular localities frequented by ships, such as roadsteads, harbours, and the mouths of rivers. All this, perhaps, every one of our readers knows; but it may not, perhaps, be so generally known that the study of the tides throws light on various high cosmical, gravitational, and physico-geographical problems.

The importance of this study is unquestionable, and, indeed, unquestioned; and it has been pursued to a limited extent by ourselves and all civilised nations at the public cost. But as yet the observations have been insufficient both as to character and as to the number of localities at which they have been taken, and also as to the reduction of them, and the deductions from them, that have been made.

Sir William Thomson accordingly brought the subject before the British Association, and obtained from that body the aid of a Committee and of small sums of money from year to year, to enable him to supply, so far as might be possible, these deficiencies. The Committee was designated "for the purpose of promoting the extension, improvement, and harmonic analysis of tidal observations;" and, having regard to the object with which we now address the scientific public, we must also give its composition, namely, Sir W. Thomson, Prof. J. C. Adams, the Astronomer Royal, Mr. J. F. Bateman, C.E., Admiral Sir E. Belcher, Mr. T. G. Bunt, Staff-Commander Burwood, R.N., Mr. Warren De La Rue, Prof. Fischer, Mr. J. P. Gassiot, Prof. Haughton, Mr. J. R. Hind, Prof. Kelland, Staff-Captain Moriarty, Mr. J. Oldham, C.E., Mr. W. Parkes, C.E., Prof. Bartholomew Price, Prof. Rev. C. Pritchard, Prof. Rankine, Captain Richards, Hydrographer to the Navy, Dr. Robinson, Sir E. Sabine, Mr. W. Sissons, Prof. Stokes, General Strachey, Mr. T. Webster, Profs. Fuller and Iselin (secretaries), and Sir W. Thomson (reporter). Every gentleman here named is favourably known, and the majority are highly distinguished, in those branches of the sciences with which the tides are connected.

The Committee has made three reports, namely, in 1868, 1870, and 1871, the two first prepared by Sir W. Thomson, and the third by Mr. E. Roberts of the Nautical Alliance Office, under whose able superintendence the computations and deductions were placed. The three reports have been published *in extenso* by the British Association in the volumes of the above-mentioned years. They bring fully under view the theoretical basis of the investigation, an account of observations made by the Committee and by the authorities, some of the conclusions deduced therefrom, and a statement of the measures recommended in order to extend and perfect our knowledge of the subject. It is impossible to exaggerate the value of these documents. They clearly define the present position of the problem, and the course which any future researches must take.

At the meeting of the Council of the Association on on November 11, 1871, the following resolutions were passed:—

(1.) That it is desirable that the British Association apply to the Treasury for funds to enable the Tidal Committee to continue their calculations and observations.

(2.) That it is desirable that the British Association should urge upon the Government of India the importance for navigation and other practical purposes and for science, of making accurate and continued observations on the tides at several points on the Coast of India.

The second of these resolutions has already been productive of fruit. Colonel Walker, R.E., the distinguished superintendent of the Great Trigonometrical Survey of India, has, under the authority of the Indian Government, established self-registering tide-gauges at several points in India, and has made adequate arrangements for the reduction of the results.

It is with Resolution (1) that we are concerned to-day, the official correspondence relating to it having been placed at our disposal for review. This consists of only two documents—a Memorial of the British Association to the Lords of the Treasury, signed by the President, and dated May 21, 1872; and the reply thereto.

The main points dwelt on in the memorial may be thus summarised:—That the primary object which the Committee have uniformly kept in view is "the practical application of their results to Physical Geography, Meteorology, Coast and Harbour Engineering, and Navigation;" that they have undertaken the reduction of twenty years' observations made with self-registering tide-gauges—"a most laborious work;" that 600*l.* has been granted by the British Association in four successive annual sums of 100*l.* and one of 200*l.*, "to pay the calculators, and to print and prepare tables, forms for calculations, &c.; that the last grant barely sufficed for the work actually in hand;" and that they now apply to the Government for the sum of 150*l.*, "to secure the continuance of the investigation."

The reply to this memorial is such that, unless printed *in extenso*, many persons would, we feel certain, refuse to believe that such a document could have been issued with the sanction of a civilised Government. We therefore now append it:—

"Treasury Chambers, June 3, 1872

"Sir,—The Chancellor of the Exchequer has referred to the Lords Commissioners of Her Majesty's Treasury the memorial of the British Association for the Advancement of Science, forwarded to him with your letter of the 21st ult., praying for Government assistance in connection with tidal observations.

"I am to state that their Lordships have given their anxious attention to the memorial, and that they are fully sensible of the interesting nature of such investigations; but that they feel that if they acceded to this request it would be impossible to refuse to contribute towards the numerous other objects which men of eminence may desire to treat scientifically.

"Their Lordships must, therefore, though with regret, decline to make a promise of assistance towards the present object out of public funds.

"I am, Sir, your obedient servant,

"(Signed) WILLIAM LAW

"Sir W. Thomson, Athenæum Club."

Nothing would be easier than to be sarcastically indignant on such a theme as this. The picture of the Lords Commissioners of H M. Treasury giving their "anxious attention" to the tides, and expressing "regret" that they cannot grant so large a sum as 150*l.* for investigations which they really think "interesting," lest eminent men should avail themselves of so imprudent a precedent, in order to make further demands for "scientifically" treating other objects of the same character—this picture is one which requires but a touch, it hardly, indeed, needs a touch, to make it a far-fetched caricature of civilised governing.

To apply the lash, however, to narrow stupidity, can only gratify temporary spleen; and we must resist the temptation in order to attain the higher object of illustrating, by this pointed example, the present condition of State science in England, and of showing what we require in order to prevent the mischief which its existing condition must cause.

To begin with the British Association. Here is a body carrying on operations by means of privately contributed funds, of very limited amount, about 2,000*l.* a year; not for the first, tenth, or hundredth time, quietly accepting as a fact that certain scientific objects of national importance will not be recognised or pursued by the Government, and, therefore, stepping in to contribute as far as they can towards their accomplishment. The Kew Observatory, the map of the moon, the utilisation of sewage, are other examples of the same kind. They have all been commenced on a necessarily miserable scale—a little advance has been made, and then the thing has dropped through for want of funds. Now, according to our apprehension the British Association, though acting with the very best intentions and motives, have greatly erred in these matters. It is absurd to suppose that any one of the numerous large national scientific problems they have taken up could be properly dealt with even if their whole income of 2,000*l.* a year had been devoted exclusively to it. The small contributions to each which they have been able to afford, if not sometimes quite wasted, have almost invariably produced results quite inadequate even to the small expenditure, simply because it was so small as to forbid really efficient measures. This is an evil, but as some good results, however slight and imperfect, have been achieved, it might be submitted to if it were all. A far greater evil, however, has been caused by the measures we allude to. An obscurity has been thrown round the great question which England must soon solve. "What is the scientific work which the Government is bound to perform for the benefit of the community at large; and what is the scientific work which cannot be performed by State agency so well as by private enterprise?"

So long as individuals, and bodies of individuals, without discrimination, attempt to do what should properly devolve on the State, so long will a Government, destitute, like ours, of a particle of the scientific element, neglect its legitimate duties. We therefore strongly counsel the British Association, at their next meeting, to take measures for classifying science under the two great heads of Public and Private, to supply the Government with a full statement of all comprehended under the first head, and to refuse a single penny of its funds to any object not distinctly appertaining to the second. This will bring matters to a crisis—and we want a crisis.

As to the Government, what can we say? Poor Mr. Law's letter speaks volumes. It plaintively confesses its total inability to grasp any State scientific problem lest it should have to deal with all. We have no heart to spurn a prostrate form so lowly and humble; but can we not raise it? Can we not introduce into our Administration a source of knowledge on which they can rely to guide them in the choice of scientific objects really profitable to the nation, and officials able to insure a proper system for the attainment of such objects?

Many minds are busy on this very question; and the fact that a maritime Government will not give 150*l.* towards investigating the tides is not likely to weaken their determination to bring it to a decisive issue.

PUBLIC HEALTH IN AMERICA

Third Annual Report of the State Board of Health of Massachusetts. (Jan. 1872.)

PUBLIC health problems in New England are very much of the same character as they are in Old England. The countries and climates are both healthy, and there is plenty of preventible disease notwithstanding. In both countries bad habits have much to do with the causation of disease. In both countries civilisation takes but small account of natural laws, and as a consequence makes one step forwards where two might be made. One reason of this is partly want of knowledge, but the report before us shows that another not unimportant cause is attempting to gain present advantages by discounting the future. It is an old story told in a new country. There is a small present profit to a small minority of the community, at the cost of the remainder; but Nature, as has been well said, "just goes on levying her own cess in her own way," *i.e.*, she sends in her account, not only to the perpetrators of the damage, but to the whole community which tacitly submits to it.

The Report consists of two portions, one part giving a brief account of the Board's proceedings, the other containing an interesting series of reports by different writers on the effects of arsenical colours on health, on mill dams and water obstructions as causes of disease, on the use and abuse of intoxicating drinks, with reference to a cosmic law of intemperance, on provision for the insane, on the use and abuse of opium. There is a curious paper on the effects on health of the use of the feet in working sewing machines. There are others on slaughtering and bone boiling, vegetable parasites and the diseases produced by them, on small-pox, and on health of towns generally, with special reference to the occurrence of typhoid fever.

Our space will only admit of a cursory glance at the chief questions dealt with in these papers as illustrations of the discounting process alluded to.

Somebody, for example, discovers that papers coloured with arsenic are fair to look on, and may possibly become a source of profit. He makes such papers, and people hang their rooms with them. The maker flourishes, and the purchasers find to their cost that they are poisoned ; but not always. If they were always poisoned they would cease to buy, but this not being the case, the law assumes the manufacture to be legitimate, and people take their chance.

The State of Massachusetts was in former times almost entirely exempted from intermittent and remittent fevers. But, unfortunately, the State has numerous "water privileges," which an industrious people may take advantage of. They erect dams and backwater large areas of land, many of which became built on, and now Massachusetts has its fair quota of periodic fevers passing into typhoid fever when the streams dry up in summer.

We next approach the *pons asinorum* of social legislation, viz., the drink traffic, which we, in this country, appear disposed to deal with by reversing the principles of political economy, which teach that demand will ensure supply. We, on the contrary, propose to cut short the supply in hope that the demand may become less in consequence. In a report on this subject, the Chairman of the Board, Mr. Bowditch, endeavours to raise intemperance causes to the dignity of a science, but then he also states that "open dram shops are an unmitigated evil." Whoever wishes to master the question of intoxicating drinks, and to learn something of the cost to a community at which the profit of vending them is purchased, will find much to instruct him in this report. The remedies suggested are shutting up drunkards until they are cured, and using beer and wine instead of spirits. Might we suggest for the consideration of our Transatlantic cousins and also of our own national temperance societies, that the amounts of crime, lunacy, and pauperism produced by drink are possibly ascertainable quantities, and that while we charge railway casualties on companies under whose administration they occur, we charge the costs of crime, lunacy, and pauperism, not on the parties who, for their own profit, are accessory to their production, but on the public at large. If we do the one why do we do the other? Why should railway shareholders be made to refund part of their profits, and publicans be allowed to pocket all theirs? And may not the cure for drunkenness be found after all in leaving supply and demand to themselves, and charging all the damage accruing to the State on the liquor retailers? Might not such a course help to reduce rates and taxes, and convert the publicans into an efficient unpaid police? At all events, it is worth while to ask these questions.

Another kindred subject is the abuse of opium. It appears that the domestic consumption of opium in the United States has increased tenfold in thirty years, for a population little more than doubled. We are sorry to say that teetotalism is blamed for this result. The reporter states that in countries where vine culture prevails drunkenness and opium eating are comparatively unknown, and he argues in favour of domestic wine manufacture as a remedy for both evils.

We learn from the paper on sewing machines, that while making a shirt requires 14 hours 26 minutes by hand, it can be put together by the machine in 1 hour and 16 minutes. A coat requires 16 hours and 35 minutes hand sewing, and only 2 hours 38 minutes by machine sewing. A silk dress can be made by machine in 1 hour 13 minutes, but requires 8 hours 27 minutes of hand labour. The work is mainly done by the feet acting on treadles, which, if imperfectly applied, make a great call on certain sets only of muscles and nerves, and the result is a development of various nervous and constitutional affections peculiar to the female sex.

The best remedy is, of course, applying a motive power to the machine, and next to this to do away with the heel and toe movement of the treadle, and to substitute a swinging backward and forward movement of the feet and legs, or by other improved adaptations of leverage.

The only other paper we can notice is the one on the effect of vegetable parasites on man, which contains a good digest of the present state of knowledge on the subject. The moral of the paper is that, if people will keep their skins dirty and thus allow their vitality to fall below par, nature will kindly step in and supply fungal spores to convert the dirt into some product which is sure to call attention to the fact.

It appears that Boston young men are apt to contract a peculiar kind of ringworm by being shaved in barber's shops, the cure for which is, of course, to learn to shave themselves at home.

These Reports will do much good by enlightening public opinion, and so leading to better habits of life and to greater consideration of the interests of others, while people are looking after their own interests, results which there is small chance of arriving at by any mere legislative enactments.

OUR BOOK SHELF

Note sur les Singes fossils trouvés en Italie, précédé d'un aperçu sur les quadrumanes fossiles en général. Forsyth Major, M.D. (Reprinted from the Proceedings of the Italian Society of Natural Sciences.)

THE primary object of this paper, which was read last month, was to describe certain fossil Simian remains which have lately for the first time been discovered in Italy. One which was found in the valley of the Arno, and presented by the Marquis Ermes-Visconti to the Museum of the city of Milan, consisted of a fragment of a maxilla with the last three molars. It is referred by the writer to a species closely related to the Barbary ape (*Macacus inuus*, Linn.), still found at Gibraltar. It appears to have been somewhat smaller than the *M. priscus* of Montpellier, described by Gervais. A second fossil, part of a mandible, belonging to the same species, has been found by M. Cocchi in the Upper Arno valley. A third, also a mandible and also discovered in Tuscany, at Monte Bamboli, has been assigned by the last-named zoologist to a species of *Cercopithecus*. Lastly, some Simian teeth from Mugello, now in the museum of Pisa, are supposed by Dr. Major to belong to a species of *Macacus*.

After discussing the characters of the soil in which the first of these fossils was found, and the other mammalian remains of the same formation—*Rhinocerus Etruscus*, *R. leptorrhinus*, *R. hemitocchus* (Falconer), *Elephas meridionalis*, *Hippopotamus major*(?), *Bos Etruscus*, *Mastodon Arvernensis*, the last being probably somewhat earlier—the author concludes that the maxilla above mentioned belongs to the later Pliocene period.

The following is a list of fossil quadrumana as yet discovered :—

EOCENE

1839 Lyell and Owen, *Eopithecus*(?), Woodbridge, Suffolk.
1862 Rubimeyer, *Cœnopithecus lemuroides*, Swiss Jura.

MIOCENE

1836 Cantley and Falconer, *Semnopithecus* sp., Sewalik, N.W. India.
1836 Baker and Durand, *Semnopithecus* sp., Sewalik, N.W. India.
1837 Cantley and Falconer, *Semnopithecus* sp., Sewalik, N.W. India.
1837 Cantley and Falconer, *Macacus erythrœus v. rhesus*, Sewalik, N.W. India.
1837 Cantley and Falconer, *Pithecia* sp., Sewalik, N.W. India.
1837 Lartet, *Pliopithecus*, S. of France.
1856 Lartet, *Dryopithecus Fontani*, S. of France.
1863 Biedermann and Heer, *Pliopithecus platyodon*, Zurich.
1870 Fraas, *Colobus grandœvus*, Würtemberg.
1862 Gacedry, *Mesopithecus Pentelici*, Greece.

PLIOCENE AND QUATERNARY

1836 Lund, *Propithecus*, *Iacchus*, *Callithrix*, *Cebus*, Brazil.*
1845 V. Claussen, *Mycetes*(?) Brazil.
1845 Owen, *Macacus pliocœnus*, Gray's Thurrock, Essex.
1859 Gervais, *Semnopithecus Monspessulanus*, Montpellier.
1859 Gervais, *Macacus priscus*, Montpellier.
1871 Gervais, *Cercopithecus*, Monte Bamboli.
1872 F. Major, *Macacus inuus*(?) Valley of the Arno.

From the restricted geographical distribution of the *Lemuridœ*, it is not surprising that no remains of this suborder have yet been discovered. The fossil monkeys as yet found in S. America belong to the *Hapalidœ* or *Platyrrhini*, still peculiar to the Neotropical region. All the rest belong to the *Catarrhini*, and some to the anthropomorphous genera. They all belong to the old world, but while some have been found in India, others inhabited Greece, France, Germany, and England.

P. S.

* Ann. Nat. Hist., vol. iii. p. 426.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Total Eclipse in Java

[Extracted from a letter from Prof. Oudemans by Mr. J. N. Lockyer.]

I WAS not fortunate on the occasion of this eclipse. I had a spectroscope of Merz, sent by the Minister of the Colonies on the advice of the Academy of Sciences at Amsterdam; but the telescope to which it was to be adapted had no clock-motion. I took it with me to the Island Lawoengan in the Pepperbay, whither a Government steamer brought me and three other gentlemen. On the day of the eclipse we had three showers before totality, sky wholly overcast; but now and then the sun broke through between the clouds. Happily the clouds opened just before totality. My observations were therefore confined, like that of the other gentlemen of my party, to the general observations, following therein principally the suggestions and indications published in NATURE. I have already sent the results to the Academy at Amsterdam; and take the liberty of offering you herewith a copy of the general report, which I made up from the several partial ones for the Government.

My observations and those of my party have given me the conviction of the existence of an optical phenomenon, besides the purely solar phenomenon; not of an atmospheric origin (there is no question whatever of this), but of rays, variable during the totality, too variable to attribute them to luminous solar matter emerging from the body of the sun itself. I could follow the rays and some rifts as far as the moon's limb.

At Bintensory, the residence of the Governor-General, they were more successful, the weather being beautiful; there, as well as at Batavia, Mr. Bergsma caused observations of the declination of the magnet to be made during the whole morning, several days before, the day of, and several days after, the eclipse, at intervals of five minutes. The observations are now reduced for the influence of the moon, and he will propose to the Government to publish these observations and their reduction apart. The result of the observations is, that the movements of the magnet-needle during the eclipse have not deviated considerably from the common diurnal movement of the declination at this time of the year.

The "flying shadows" were very remarkable at Buitensorg, they were observed by persons wholly unacquainted with the phenomenon.

They were seen by Mr. Bergsma on a white wall directed E. 13° 30′ N. to W. 12° 30′ S., and on a sheet of white paper lying on a table. On the wall the shadows were inclined to the west, making with the horizontal line an angle according to one observer's measurement of 40°, and according to another's of 45°. They moved from E. to W. On the white paper they made an angle of 45° with the edges, which were perpendicular to the wall; they moved on the paper from S.E. to N.W. The phenomenon did not show itself as it is represented in "Secchi's Le Soleil," p. 158.

The shadows had a breadth of 5 to 6 centimetres; they were limited by lines with small irregular undulations; they were separated by regularly illuminated bands; the distance of the shadows was, according to Dr. Scheffer (the botanist), 1½ decimetres, and, according to Mr. Lang, about 3 decimetres or a foot. They moved parallel to themselves slowly; their velocity over the wall was about that of a horse in a moderate trotting pace. Mr. Bergsma saw the shadows from about three minutes before totality.

During totality they were not visible according to Mr. Lang, whom Mr. Bergsma had requested to pay particular attention to this point, only Mr. Lang saw now and then a slight change in the intensity of the light on the paper.

Immediately after totality the shadows appeared again, increasing and diminishing alternatively in strength, but growing gradually less and less distinct, although Mr. Bergsma continued to see them till about 5 minutes after totality.

Mr. Bergsma now describes the means proper to obtain more reliable observations on future occasions.

By construction and calculation I have deduced from Mr. Bergsma's data as to the direction of the shadows on the wall and the paper the following :—

I assumed the inclination of the lines on the wall to be 42½° with respect to a horizontal line, taking the mean between the computations of Messrs. Lang and Scheffe. That the shadow-lines made an angle of 45° with the edges of the paper, could be understood on two different theories—viz., that their azimuth was 121½° and 211½° (N.E.) Mr. Bergsma declared that 211½ was meant.

Now, if we pass a plane through a shadow-line on the wall and its prolongation on the paper, this plane intersects the horizon along a line directed in an azimuth of 31½° (N.E.), whereas the same plane has an inclination of 52⅓° to the west.

The normal on this plane meets the sky in a point having an azimuth of 121½°, and an altitude of 37⅔°. At the middle of totality the sun had an azimuth of 131°·4, and an altitude of 54°. Accordingly there is a difference of 10° in azimuth, and 16° in altitude. As regards the rough computation of the direction of the shadow-lines, this error may easily have been made, the more so as the observers were not prepared for an accurate observation of the phenomenon.

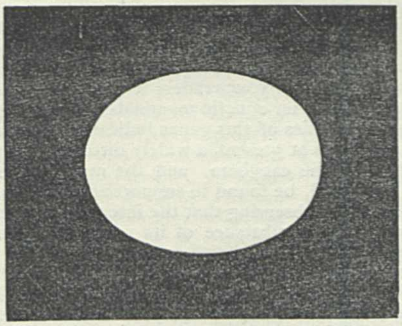
Thus it appears, without anticipating more accurate observations on the occasion of late eclipses, that the shadow-lines were situated in planes perpendicular to the sun's rays. They moved *from* the sun.

Singularly enough, neither at Tjilentap nor at the island Lawoengan, was anything of the phenomenon seen. At the island circumstances were very unfavourable, but at Tjilentap the sky was clear. OUDEMANS

Batavia, April 28

The Great Storm of June 18

OUT of a large quantity of hailstones collected here after the storm had subsided, and which were therefore partly melted, I selected one of the largest. The subjoined boundary line is the measure of a section of this hailstone through the poles, the



form of it being a prolate spheroid, flattened on two sides, like a confectionary lozenge, if I may employ so vulgar a comparison. Many of the hailstones, however, as they fell, were jagged pi ces of ice, the like of which I have never seen.

Edgbaston, Birmingham, June 21 C. M. INGLEBY

Spectrum of Lightning

I HAD a good view of the spectra of lightning during the storm of yesterday. Frequently there was only one bright line visible, this being coincident with the nitrogen line. At other times there were several bright lines, sometimes with, and at other times without, the nitrogen line. Several flashes showed a continuous sprectrum without visible lines. My instrument was a small direct-vision spectroscope, but sufficiently powerful to divide the sodium line. J. P. JOULE

Broughton, Manchester, June 19

YESTERDAY this neighbourhood was visited by a most terrific thunderstorm, such as I have never before seen in England. Indeed, it is stated that the last storm of similar severity occurred exactly 33 years ago to a day—rather a singular coincidence. The storm commenced here about half-past one, though distant thunder was audible at one o'clock. It was accompanied by violent wind, rain, and hail, and lasted about an hour, during which 0 66 in. of rain fell. The wind was S.E. at the time, but the storm came from the W. The hailstones are described as being, many of them, larger than marbles, and did a good deal of damage to glass. Several fatal accidents have occurred from the lightning, which for some time was almost incessant. I examined its spectrum with a miniature spectroscope, and succeeded in observing four or five lines. Their approximate positions, which I give below, are very roughly determined, and especially so toward the red end. They were obtained by comparison with the Fraunhofer lines, and with the carbon spectrum of a Bunsen burner. The former were mostly very faint from the darkness, but the atmospheric absorption bands near D were very marked. I am strongly of opinion that the spectrum is that ordinarily given by a spark in air, but was unable to make direct comparison. I have since examined a feeble spark by the same spectroscope, and the general appearance is very similar. I also tried observation of the long zig-zag flashes with a simple prism, but without much success, though I was able to see the spectrum. H. R. PROCTER

North Shields, June 19

Lines.	Wave-length.	Remarks.
α	about 66 8th-metres	—
β	,, 59 ,,	Doubtful.
γ	,, 56 ,,	—
δ	,, 53 ,,	—
ε	,, 50 ,,	Bright.

Water Analysis

MY attention has been directed to an article entitled " Water Analysis, I." published in NATURE of June 6. The article is unsigned, bearing neither name nor initials, and contains strange errors and misrepresentations, some of which I beg permission to correct.

First, there is a false date. The article states that in 1868 " Messrs. Chapman, Wanklyn, and Smith proposed to determine the organic matter in water from the amonnt of ammonia evolved when the water was treated with a strongly alkaline solution of potassic permanganate, and then distilled." The truth is, that our paper, proposing the process, and giving directions how to work it, together with examples, was read before the Chemical Society on June 20, 1867, and published in the *Journal* for the year 1867 (*vide* p. 445, *et seq*). Moreover, in the year 1867, our process was extensively employed by the Rivers Commission by Mr. Way, who was at that period the chemist on the Commission.

Next, I have to notice a misrepresentation. The article describes us as having at first stated that albumen gave up the whole of its nitrogen (in the form of ammonia) when treated with alkaline permanganate, and that afterwards we said that only a certain fraction was obtainable in that way.

We have never said that distillation of albumen with alkaline permanganate converted the whole of the nitrogen of the albumen into ammonia. The assertion in the article is therefore untrue. The circumstance to which your statement was intended to refer was the following.

In our paper read on June 20, 1867, we proposed two distinct modifications of the water process. In the one modification we evaporated to dryness with potash in the oil-bath, and afterwards distilled the residue with alkaline permanganate. The quantity of ammonia got by the operation with potash in the oil-bath, *plus* the quantity of ammonia got afterwards by permanganate of potash, is equal or nearly equal to the total ammonia which the total nitrogen of the albumen will yield.

On June 20, 1867, in addition to this early form of the water process, we described and recommended a second modification, consisting in the omission of the evaporation to dryness with potash. We boiled with potash, but did not take down to dryness, and then boiled with permanganate. At that date we knew, and mentioned in the paper, that omission to take down to dryness involved some loss of ammonia which potash should evolve. We did not know that failure to get the full yield with potash involved the ultimate sacrifice of a certain quantity of ammonia. That fact was afterwards ascertained by me, and published later in the autumn of 1867, and is duly recorded in the *Journal of the Chemical Society*.

The conviction that a really serviceable process of water-analysis must be a simple one, and the perception that a definite fraction of the total nitrogen was as good a datum as the total nitrogen itself, led me to persist in recommending the second modification rather than the first. Much experience in these matters has confirmed my judgment, and I do not repent the choice that we made.

Returning to the article. After having mentioned our experiments on papaverine, sulphate of cinchonine, narcotine, strychnine, sulphate of quinine, there is the following extraordinary statem nt :—

" If the authors had enabled us to ascertain the absolute error on the quantity taken instead of the percentage error, by giving us the quantities from which the results were taken, it would no doubt be much more apparent : the results given above in the case of Frankland and Armstrong's paper are absolute errors."

I invite you to open the *Journal of the Chemical Society*, May 1868, which is referred to in our treatise. We did give the quantities from which the results were obtained. Quoting from our memoir, you may read that we took 10 mgrm. of papaverine, and obtained 0·22 mgrm. of ammonia; that we took 10 mgrm. and 5 mgrm. of sulphate of cinchonine, and got respectively 0·57 and

0·27 mgrm. of ammonia; that we took 5·5 mgrm. of strychnine and obtained 0·30 mgrm. of ammonia; and that we took 10 mgrm. of sulphate of quinine and obtained 0·45 mgrm. of ammonia.

The absolute errors, therefore, were—

	Milligrammes of ammonia. Calculated.	Found.	Error.
Papaverine	0·25	0·22	0·03
I. Sulphate of cinchonine	0·48	0·57	0·09
II. ,, ,,	0·24	0·27	0·03
Strychnine	0·28	0·30	0·02
Sulphate of quinine	0·456	0·45	0·006

giving a mean error of 0·035 mgrm.

I have to remark, in reference to these five examples, that they are not cases selected by me to exhibit the accuracy of our process, but cases picked out from a great number, in order to exhibit what takes place under the most unfavourable circumstances. In contrast with these are Frankland and Armstrong's six determinations, five on urea and one on hippuric acid, given by themselves as exemplifying the accuracy of their method, and showing a mean error of 0·35 mgrm. of nitrogen—just ten times as much as ours under the most unfavourable conditions.

I observe you say that the amount of ammonia obtainable from albumen by the action of alkaline permanganate is influenced by the degree of concentration of the solution, the amount of heat applied to the retort, and consequent rate of distillation, and the time to which the solution is exposed to the action of the alkaline permanganate.

It would be just as true and as much to the point to say that the amount of carbonic acid obtainable from sugar depended on the amount of oxide of copper with which it is mixed, and the length of time to which it is exposed to a red heat.

I am able to affirm most positively that there is no difference in the yield of ammonia from albumen, whether the solution be of a certain strength or six times as strong, or whether the distillation be rapid or slow; and in proof of this I refer to a set of experiments on albumen, published in 1867. If the action of the permanganate be pushed to the ultimate limit, the yield of ammonia is constant.

Your assertion that water which has been distilled from permanganate, and gives no reaction with the Nessler test, yields ammonia on being again distilled with permanganate, will not astonish persons who have had experience in the working of our process. The explanation of this fact is now, I believe, tolerably well understood, and is simply this: that when water contains so minute a quantity of ammonia as not to impart a colour when 100 cubic centimetres of it are treated with Nessler test, it may still contain sufficient ammonia to yield a perceptibly ammoniacal distillate if one litre be made to yield 100 cubic centimetres of distillate.

In conclusion, you mention some difficulties in applying our process to the effluent water from sewage farms. I will not, on this occasion, describe how these difficulties are overcome. Suffice it to say that they have been overcome by very simple and obvious means. J. ALFRED WANKLYN

11, Harrington Street, London, June 17

Parasite of the Beaver

MAY I occupy a few lines of your valuable space for a brief note upon the singular parasite of the beaver, *Platypsylla castoris* Ritsema (*Platypsyllus castorinus* Westwood)?

On the kind application of Messrs. Wayers and Roelofs, of Brussels, Mr. Ritsema very courteously presented me, some months ago, with a pair of this insect, the remarkable characters of which seem to deserve a more extended notice than has been given by himself or by Prof. Westwood, who almost at the same time described it from specimens obtained from a different source.

The former has classed it with the so-called suborder, *Suctoria*, or *Aphaniptera*, as a family or series equal in value to the *Pulicidæ* (fleas, jiggers, &c.), while the latter considered it so peculiar as to represent a new order of insects, which he named *Achreioptera*.

After a careful study of a series of beautiful dissections made for me by my friend the Rev. A. Matthews, I have to dissent from both of these views, and to regard it, in accordance with my impressions at first sight, as *Coleopterous*.

The appearance of the insect is such as to mark it, on the most superficial inspection, as a distinct family. In the wonderful structure of the mentum, with three immense posterior lobes, it shows an affinity, though remote, with the singular genus, *Leptinus*, which is also the type of a family (*vide* Le Conte, Proc. Acad. Nat. Sciences, Philadelphia, 1866, p. 368). But the lateral lobes in *Platypsylla*, broad triangular processes, are in *Leptinus* only narrow spines, projecting in the same manner over the gular plate.

In the form of the antennæ it resembles *Gyrinus* and *Parnus*, and in other less important parts of the body it has unmistakable affinities with various members of the Clavicorn series, such as *Staphylinidæ*, *Silphidæ*, and *Corylophidæ*, though especially with *Trichopterygidæ*, in the very extraordinary genus *Limulodes*, Matthews.

A very rare character is the reception of the antennæ in cavities on the dorsal surface of the prothorax; such characters are found in *Physemus* of the *Byrrhidæ*, *Mychocerus* Er., the affinities of which are doubtful, and in *Usechus* Motsch. of the *Tenebrionidæ*. In those three genera the antennal cavities are round fossæ, while in *Platypsylla* they are grooves extending along the whole lateral margin.

My object in the present note is not so much to express an opinion on the systematic position of this wonderful animal (which I will discuss fully in an illustrated memoir now in preparation), as to call the attention of your readers to the possible occurrence of similar epizoa on other aquatic mammals, especially rodents.

The complex affinities of this genus indicate that it either was in former times, or is at present, a widely distributed type. The European beaver, the capybara, and the musk rat, may, perhaps, when examined, be found to support allied forms.

I will conclude by observing that the insect has no organs with which to perforate the substance of its patron, and cannot eat living tissues or fluids; it is, therefore, not a parasite in the strict sense of the term, but an inquiline, living upon effete material, perhaps epidermal scales. The larva should be diligently sought for by those that have the opportunity, both in the houses and on the bodies of the beavers, as a knowledge of the development and transformations will be of importance in recognising more fully its affinities.

I trust that this note may stimulate further investigation on the part of some of your readers.

Lausanne, June 19 JOHN L. LE CONTE

Vespertilio

YESTERDAY a neighbour, in cutting down a very old, wide-spreading broadleaf (*Griselinia littoralis*), came suddenly on a great crowd of bats. Whilst he was chopping he noticed that his dog seized something, which he found to be a bat. From a huge hollow limb of the tree seventy-five bats were dislodged; they fluttered into the bush, keeping just above the ground.

Ohinitahi, New Zealand, Feb. 14 T. H. POTTS

Origin of Cyclones

I HAVE to thank Mr. Whitmee for his statement about the formation of cyclones at the Samoan and neighbouring islands in the latter part of the Southern summer. It will be seen that though I was ignorant of the fact when I wrote in my former letter on cyclones, it confirms my theory that they originate "in the meeting of the trade-winds in the northern and southern hemispheres, at some distance north or south of the equator." The cyclone region in which the Samoan and Fiji islands are situated is probably an extension of that of the Southern Indian Ocean. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, June 17

THE POPULATION OF THE PHILIPPINE ISLANDS

ACCORDING to the latest, not yet published, statistics, the Philippine Islands are inhabited by 7,451,352 inhabitants, distributed into 43 provinces and 933 cities or villages. 1,232,544 pay tribute to the Government, and the number of 7,451,352 is calculated on the supposition that about the sixth part of the whole has to pay tribute. As there exist in all the islands, even in Luzon, independent tribes, and a large number in Mindanao, the number of 7,451,352 gives no correct idea of the real population of the Philippines. This is not known at all, and will not be known for a long time to come.

The number of 7,451,352 is composed in the following manner:—

The Island of Luzon	4,467,111	in	508	villages
,, ,, ,, Panay	1,052,586	,,	92	,,
,, ,, ,, Cebu	427,356	,,	51	,,
,, ,, ,, Leyte	285,495	,,	43	,,
,, ,, ,, Bohol	283,515	,,	36	,,
,, ,, ,, Negros	255,873	,,	43	,,
,, ,, ,, Samar	250,062	,,	35	,,
,, ,, ,, Mindanao	191,802	,,	64	,,
,, ,, ,, Mindoro	70,926	,,	18	,,

The remainder on the other small islands.

The following is the division into 43 provinces:—

Abra	37,266	in	8	villages
Albay	341,493	,,	38	,,
Antique	131,886	,,	19	,,
Basilan	600	,,	1	,,
Bataan	67,362	,,	12	,,
Batangas	432,504	,,	21	,,
Bulacan	346,317	,,	24	,,
Bohol	283,515	,,	36	,,
Burias	2,430	,,	1	,,
Cagayan	114,396	,,	19	,,
Calamianes	27,189	,,	5	,,
Camarines North	42,525	,,	9	,,
,, South	434,016	,,	34	,,
Capiz	272,292	,,	32	,,
Cavite	173,193	,,	19	,,
Cebu	427,356	,,	51	,,
Cottabato	1,200	,,	1	,,
Davao	1,860	,,	1	,,
Hoilo	648,408	,,	41	,,
Hocos North	220,038	,,	15	,,
,, South	265,233	,,	21	,,
Islas Batanes	12,000	,,	6	,,
Isla de Negros	255,873	,,	43	,,
Isabela	47,067	,,	9	,,
Laguna	216,435	,,	28	,,
Lepanto	56,088	,,	81	,,
Leyte	285,495	,,	43	,,
Manila	354,348	,,	29	,,
Mashate y Ticao	17,190	,,	9	,,
Mindoro	70,926	,,	18	,,
Misamis	100,398	,,	32	,,
Morong	73,080	,,	12	,,
N. Ecija	167,325	,,	23	,,
N. Vizcaya	21,471	,,	6	,,
Pampauga	300,567	,,	29	,,
Pangasinan	431,691	,,	30	,,
Romblon	34,137	,,	9	,,
Samar	250,062	,,	35	,,
Surigas	73,770	,,	28	,,
Tayabas	155,280	,,	17	,,
Union	133,452	,,	13	,,
Zambales	109,044	,,	23	,,
Zamboauga	14,574	,,	2	,,
	7,451,352*		933	

The following division of the Philippine Islands is proposed, but not yet introduced:—

18 Provinces in 3 divisions

1st division.—Manila, Hoilo, Cebu, Hocos, Cagayan.

2nd division.—Pangasinan, Pampauga, Laguna, Cavite, Batangas, Albay, N. Ecija.

3rd division.—Bulacan, Camarines, Capiz, Negros, Leyte, Marianas.

The Islands of Mindanao, Basilan, Tolo (Soolo), Samales, and Balabac, will have a special government.

ADOLF BERNHARD MEYER

Manila, April 15

* The Marianas Islands belong to the Government of the Philippines with 8,000 to 9,000 inhabitants.

MINERAL SPRING OF SHANA NEAR TREBIZOND

THE mountainous and volcanic district, or, to speak more correctly, belt, which skirts the northern coast of Asia Minor, beginning from Amastri, one hundred and fifty miles east of the Bosphorus, up to the Georgian valley and the Russo-Caucasian frontier, abounds in mineral springs, varying as to temperature and constituents, but generally endowed with hygienic properties, which are, to a certain extent, known and appreciated by the natives of the land. But few of these springs have been made the subject of scientific examination and analysis; so that the ingredients whence they derive their value, where not discernible to the unassisted senses, are in most cases matter of conjecture rather than of demonstration.

In one instance, however, that of a remarkable mineral source within this district, the obligingness of a resident Italian chemist, M. Marengo by name, has lately furnished me with some scientific data, not indeed as complete as might have been desired, yet enough for interesting information. These I will now give, accompanied by my own observations made during frequent visits to the locality in question.

About six miles east of Trebizond on the sea-coast stands the little fishing village of Covata, at the entrance of the valley which, as also the stream that flows down it, bears the same name. Following the valley some way inland towards the mountains where it originates, we come on the water-course and ravine of Shána, falling into that of Covata at nearly right angles, from east to west. "Shána" is, like most names of places hereabouts, a word of Laz, that is Mingrelian, origin, and signifies "heat." This ravine is narrow and deep; the rocks on either side are volcanic, chiefly mottled tufa of dark grey substance, speckled throughout with small black fragments of irregular shape and size imbedded in it. Vegetation, wherever the steepness of the slope allows it to take root, is most luxuriant; vines, olives, walnut trees, chesnut, sycamore, maple, poplar, with a dense undergrowth of alder and hazel. Down the bottom of the gorge flows a small torrent, which joins the river of Covata not far from its sea-mouth.

Tracking the narrow path which leads up to the Shána gorge for about four hundred yards, we come on a sort of widening-out, where a horizontal sheet of porous volcanic rocks spreads to some distance alongside of, but slightly elevated above, the course of the torrent. In the middle of this rock-sheet has been formed, partly by nature, partly by art, a small circular basin, nearly three feet in diameter, and averaging a foot or rather more in depth. This is constantly full of clear, limpid-looking water, which wells up through several irregular clefts in the stone bottom of the basin, and overflows it, the waste running off down the ledge into the neighbouring torrent, and leaving everywhere on its passage a thick bright-red deposit of oxide of iron, which stains the rocks, and even discolours the main-stream to some distance. Through the clefts just mentioned bubbles of carbonic acid gas rise in sufficient abundance to give the water the appearance of boiling; but the temperature is normal. This water is strongly impregnated with free carbonic acid; its taste is pungent and ferruginous, with a distinct, but, so long as it is fresh, a not unpleasant indication of sulphur. If it is put into a bottle, corked, and exposed to the heat of the sun, the expansion of the gas soon causes an explosion, driving out the cork, and even bursting the bottle.

Near this semi-artificial basin, and placed on a line with it one after another in the axis of the valley, are two other natural rock-hollows, one of several feet in extent, the other less; whence the same description of ferruginous water, mixed with bubbles of carbonic acid gas, issues continually, but not in equal abundance, the fissures below being partially choked up, whereas those in the circular basin are carefully kept open by the peasants. Here, too, the rock around is stained with bright red streaks of iron deposit. Also, carefully observing the torrent itself, which flows in a parallel direction a few feet distant, I noticed that bubbles of gas kept rising here and there from between the stones in its bed, and that the water, though tasteless higher up, here partook to a certain extent of the mineral acidity so strongly marked in the springs.

The analysis of the ingredients of the "Shána" water, as supplied me by M. Marengo, was not quantitative, but merely qualitative. I give it as follows, apologising at the same time for any technical inexactitude in my translation from the letter of the Italian document now before me:—

INGREDIENTS

Hydrosulphuric Acid	Abundant
Carbonic Acid	Abundant
Sulphuric Acid	Not much
Chlorine	Scanty
Oxide of Iron	Very abundant
Lime	Abundant
Magnesia	Abundant
Alumina	Scanty
Soda	Scanty
Potash	Trace
Silica	Trace

Iron, free carbonic acid, sulphur, and magnesia, are the chief characteristics of this spring.

Among the Mahometan and Turkish-speaking population of the neighbourhood, the source goes by the name of "'Ilijeh," or "Healing," a term which they apply to almost every mineral spring of whatever description. As for this one in particular, the natives ascribe to it almost every sanatory virtue that a Holloway's advertisement could claim. In reality it is tonic, and, if its use be persevered in, alterative; the magnesia which it contains renders it at first slightly laxative. A considerable quantity of the water is brought in jars or bottles, which are filled and closed on the spot, to Trebizond, where it is much esteemed. The supply is unaffected by change of weather or season; only in summer the water is a few degrees cooler, as in winter warmer, than that of the torrent close by, which is often, during the severity of a Black-Sea February, changed into ice; whereas the little circular basin, in spite of its shallowness, never freezes.

The so-called "Greeks," who have a small peasant colony in the neighbourhood, have christened the source, in their modern corrupt dialect, "Iäsma," the correct word being Ἁγίασμα, or "sanctification," and have erected on an over-hanging rock close by, a small chapel, dedicated to I know not what saint, the supposed patron of the waters. The Turks, on the contrary, attach to it no religious idea whatever.

The peasants report the existence of another ferruginous spring some miles farther on among the mountains, ; but the precipitous character of the paths leading to it and the density of the forests, render it practi cally inaccessible to all but themselves.

Trebizond, May 28 W. GIFFORD PALGRAVE

THE DISPERSION OF SEEDS BY THE WIND

IN the very interesting notice of Grisebach's "Vegetation der Erde," which appeared in a recent number of NATURE,* reference is made to a paper by Kerner of Innsbrück, "On the Influence of the Wind on the Distribution of Seeds in Mountain Regions." As this paper was presented to the German Alpine Club, and no translation, as far as I am aware, has appeared in this country, with the exception of an abstract in the *Gardener's Chronicle*, it is probably almost unknown to English readers, and a short epitome of its most interesting features may not be unacceptable.

* Vol. v. p. 458, April 11.

The idea that the wind performs a very important part in the distribution of plants, by the extensive dispersion of their seeds, is a very prevalent one. Mr. Bentham has, however, pointed out in his Anniversary Address to the Linnean Society in 1869, that this popular belief rests on insufficient data. If that portion of thistle-down which has been carried to a considerable distance by a high wind is carefully observed, it will generally be found to have left its seed behind it; and in the same order of Compositæ, several species of *Eclipta*, *Elephantopus*, *Anthemis*, and *Lapsana*, which have no pappus, have a much more wide-spread distribution than the majority of *Senecios*, for instance, with their light and broad pappus. The rapid spread of our common thistle, *Carduus arvensis*, in any new country where it once gains a foothold, is probably as much due to the persistent vitality of its roots as to the dispersion of its seeds. If the individuals in the same field are examined, they will generally be found to be all of one sex, showing that they must have been propagated by the division of the same individual. Of the extraordinarily rapid power of dispersion possessed by some plants independently of their seeds we have a familiar instance in the suddenness with which the Canadian water-weed, *Elodea canadensis*, filled up all our canals and water-courses within a few years of its first introduction; and yet up to the present time the male plant is entirely unknown in this country, and indeed in Europe; and it is probable that the whole of the stock now in England may have sprung by sub-division from the first imported specimen.

M. Kerner conceived the idea that a careful examination of the plants growing on moraines, and of the seeds found on the surface of glaciers, would throw considerable light on this interesting subject, since it is evident that they could only have arrived in those localities by the agency of the wind; and the results of an elaborate series of investigations are recorded in the pamphlet alluded to. Firstly, with regard to the moraines:—A list of five of these floras, from as many different moraines, consisting of limestone, schist, and gneiss, included 124 species, the following orders being the most largely represented:—Compositæ, 23 per cent.; Caryophylleæ, 10 per cent.; Gramineæ, 8 per cent.; Mosses, Saxifrageæ, and Salicaceæ, 6 per cent.; Cruciferæ, 5 per cent.; Ferns and Rosaceæ, 4 per cent.; Scrophulariaceæ, 3 per cent. Of the smaller families, the genera *Valeriana*, *Epilobium*, and *Juncus*, occurred the most frequently. The investigation of these lists, with a view to trace the origin of the plants, shows that the larger number of those which constitute the moraine flora are species widely distributed over the higher mountain regions in immediate proximity to the glacier. Less frequent are those plants which belong to the grassy plateaux of the lower elevations; and still less common species belonging to the meadow or wood flora of the lowlands, which maintain only a short and precarious existence.

The absence of this latter class of plants might, however, be due to the inability of the seeds to germinate under such unfavourable circumstances; and in order to determine this point, M. Kerner carried his researches to the surface of the glacier itself, examining both the animal and vegetable productions found thereon, with the following results:—

The animals found were entirely dead or benumbed insects belonging to the orders Lepidoptera, Hymenoptera, Coleoptera, and Diptera, and consisted of forty-three species, a considerable portion of which are found only in the highest mountain regions in the immediate vicinity of the glaciers; more than half the species were of very wide distribution, extending from the mountain valleys and neighbouring plains to the edge of the glaciers; very few being found only in the mountain valleys, and one only, the common honey-bee, being peculiar to cultivated districts. None of the insects found belong to extra-Alpine species, none of the kinds peculiar to the warm valleys of the southern Alps are represented; and the inference is unavoidable, that all the animals found on the glaciers have either strayed voluntarily, or have been driven by the wind, from districts immediately adjacent to the glacier.

The task of determining the seeds found on the surface of the glacier was much more difficult. The seeds of many Alpine plants have hardly been described; and in other instances it is difficult to distinguish between those belonging to several different species of the same genus. Thirty-six species, however, were determined with tolerable certainty, the majority of which were identical with the species previously recorded as inhabitants of the moraines. Here again the same results are established: not a single seed is found on the glacier, as not a single plant on the moraine, which does not belong to a species inhabiting the immediately adjacent mountain slopes or valleys. The conclusion from these facts seems inevitable, that the conveyance of seeds, even when provided with apparatus calculated for being floated in the air by horizontal currents, takes place only within very circumscribed limits; and that the prevalent opinion that they may be thus carried for very great distances is not supported by facts.

M. Kerner thus sums up the results of his observations:—

1. Only dust-like substances, such as pollen, spores, diatom-scales, &c., can be distributed by currents of air over wide stretches of land and sea in uninterrupted flights, and thus be brought into the alpine regions.

2. Fruits and seeds of flowering plants which are provided with a web-like floating apparatus that distends itself in dry air in the form of a parachute, are carried upwards by the ascending current of air which arises on sunny days in alpine regions on the cessation of the horizontal wind; but after sunset they sink again to the ground at a short distance in a horizontal direction; and the object attained by this floating apparatus is not so much the adaptation of the seeds for long journeys, as to enable them to settle on the projections and in the crevices of steep precipices and rocks, and to clothe with vegetation these rock-walls which are not easily accessible by other seeds.

3. The presence of membranous margins and wings favours the transport of fruits and seeds by horizontal currents of air; the horizontal distance, however, over which these seeds are carried scarcely ever extends farther than from one side of a valley to the other, and the distribution of the fruits and seeds of flowering plants, in so far as this is caused by currents of air, can only proceed gradually and step by step.

4. Fruits and seeds which are deficient in any kind of appendages that facilitate flight are scarcely influenced by currents of air; it is only when these seeds are of very minute size and extremely small weight that they can be driven short distances by horizontal winds.

It appears, therefore, that the idea that seeds are distributed to great distances by the wind, if not to be treated as a popular error, at least requires a much larger foundation of fact than it at present possesses, in order to be accepted as a scientific truth. A series of observations of this nature, if carefully conducted, is a substantial gain to Science, and may assist the determination of great physiological questions in hundreds of ways. They are within reach of every intelligent resident in the country possessed of ordinary powers of observation; and yet how few interest themselves practically in carrying them out!

A. W. B.

LYELL'S PRINCIPLES OF GEOLOGY *

IN our last notice, after a sketch of the methods of investigation employed by Sir Charles Lyell, and an outline of the principles deduced therefrom, we gave a few examples of the kind of proofs brought forward by him to show that the degrading and transporting forces which we see in operation are producing similar phenomena to those we observe in the sedimentary rocks, and that, given sufficient time only, effects on as great a scale must be the inevitable result.

We will now select some of the evidence adduced by him to show that the igneous forces also, the movements of upheaval and depression, are as active, and the products of eruption on as grand a scale, as we have any reason to believe they have ever been within the period over which our observations extend.

The consideration of what suggested the former greater intensity in the subterranean forces, viz., the supposed vast magnitude of the ancient igneous rocks, and the proofs of variations in climate, leads Sir Charles into an investigation of the astronomical and geographical causes of vicissitudes of climate, which involves an inquiry into the vexed questions of oceanic circulation, and the effect of various changes of conditions on the organic world in the extinction of species, and their replacement by new forms of life.

It certainly may at first seem difficult to believe that the forces which produce upheaval and eruption have not varied in intensity throughout the whole period of which we have any record, and yet that over many large tracts of country, where now the faintest vibration of the distant earthquake is exceptional and rare, we have thousands of feet of volcanic ash and lava, and great masses of matter which have apparently been injected in a molten state into the fissured rock. But this difficulty has arisen because the vastness of the ancient volcanic deposits has been assumed without sufficiently detailed observation, and the magnitude of modern igneous action has been underrated, while the most important point, the transference of paroxysmal action from one area to another, has been overlooked.

Speaking of contemporaneous volcanic deposits in the older rocks, Sir Charles Lyell says:—"If one of these igneous formations is examined in detail, we find it to be the product of many successive ejections or outpourings of volcanic matter. As we enlarge therefore our knowledge of the ancient rocks formed by subterranean heat, we find ourselves compelled to regard them as the aggregate effects of innumerable eruptions, each of which may have been comparable in violence to those now experienced in volcanic regions" (p. 114). This question, however, Sir Charles does not investigate in the "Principles," which deals with the modern changes of the earth; and we will pass on to notice some of the examples he gives to show the magnitude of modern igneous action.

First, as to the fact that changes of level are going on:—"Recent observations," says Sir Charles Lyell, "have disclosed to us the wonderful fact that not only the west coast of South America, but also other large areas, some of them several thousand miles in circumference, such as Scandinavia, and certain Archipelagos in the Pacific, are slowly and insensibly rising; while other regions, such as Greenland and parts of the Pacific and Indian Oceans, in which circular or coral islands abound, are as gradually sinking" (p. 128). The atolls are themselves a proof of oscillations of level. The coral zoophytes live only within certain distances from the surface, and, having com-

* "The Principles of Geology, or the Modern Changes of the Earth and its Inhabitants considered as Illustrative of Geology." By Sir Charles Lyell, Bart. Eleventh and entirely revised edition. (London: J. Murray, 1872.) (The Second Volume has been issued since the appearance of our last notice; see NATURE v. p. 456.)

menced nearly all round an island, keep building up as the island goes down till they have formed a ring of coral. The accompanying ideal section across such an island enables one to understand the mode of growth. A channel is kept open through one side, probably at first by the stream, which drains the island, and carries down mud and fresh water, and afterwards by the scour of the tide. Whenever an area covered by such islands is upheaved, and the reefs lifted up above the breakers, or the

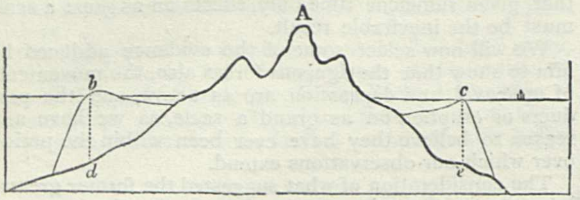


FIG. 1.—SUPPOSED SECTION OF AN ISLAND WITH AN ENCIRCLING REEF OF CORAL

A The Island; *b*, *c* highest points of the encircling reef between which and the coast is seen a space occupied by still water.

waves and wind have heaped up broken coral rock and shell around, the surface soon gets weathered, and forms a soil on which plants and animals settle and live. Sometimes the top of the island around which the coral was built is still seen; sometimes it has disappeared altogether beneath the sea. We subjoin a sketch of one of these circular reefs.

But besides such indirect evidence of gradual change of level, it is a matter of observation that as an accompaniment of volcanic action we frequently have sudden movements of small extent. For instance, in the destructive earthquake which visited Chili in 1822, the coast was raised from 2 ft. to 4 ft., while farther inland the rise was estimated at from 5 ft. to 7 ft., and off the port of Penco, if the reports of the inhabitants are to be believed, there was a rise of 24 ft. during the single earthquake of 1751. In New Zealand, during the earthquake

FIG. 2.—VIEW OF WHITSUNDAY ISLAND

of 1855, a fault 10 miles long, with a displacement of 9 ft., was produced.

Supposing an elevation of 7 ft. occurred only once every century, it would require less than 150,000 years to form a chain as high as the Pyrenees, and if repeated three times in a century would be sufficient to account for the Andes in the same time.

"It may be instructive," says Sir Charles, "to consider these results in connection with others already obtained from a different source, and to compare the working of two antagonistic forces—the levelling power of running water, and the expansive energy of subterranean heat. How long, it may be asked, would the Ganges require . . . . to transport to the sea a quantity of solid matter equal to that which may have been added to the land by the Chilian earthquake? The discharge of mud in one year by the Ganges at its mouth was estimated at 20,000,000,000 cubic feet. According to that estimate it would require about four centuries before the river could bear down from the continent into the sea a mass equal to that gained by the Chilian earthquake" (p. 97).

In volcanic districts especially we may expect evidence of recent upheaval and depression, and so we often have marine beds forming the base of a volcano, or submerged volcanos, whose leading features seem to be due to subaerial action. We may, for instance, mention the case of Etna, and refer our readers to the interesting line of reasoning by which our author works out the history of that mountain, showing that it was formed by degrees, of matter heaped up upon marine beds of comparatively recent age, which have now been lifted up to a considerable height above the sea, and further proves that at one time there were two principal craters from which matter was ejected, but that now, owing to subsequent explosions and denudation, an enormous valley occupies what was the top of the mountain.

As an example of a submerged volcano we may mention Santorin, with regard to which Sir Charles Lyell says:—

"We may conceive, therefore, if at some former time the whole mass of Santorin stood at a higher level by 1,200 feet, that this single ravine or narrow valley, now forming the northern entrance, was the passage by which the sea entered a circular bay. But at a still earlier period, when the ancient volcanic cone—of which the outer islands are the remains—was still more elevated above the level of the sea, there may have been a deep valley of subaerial erosion cut by the principal river which then drained Santorin, which may have consisted of one lofty volcanic cone, afterwards truncated by a paroxysmal explosion such as we have already spoken of in the case of Galongoon" (p. 72).

We subjoin Sir Charles Lyell's sketch (Fig. 3), which it will be interesting to compare with that of the unsubmerged summit of Etna.

We select also his ideal section across Barren Island (Fig. 4), to help to realise its manner of formation.

It may be worth calling attention to the similarity between the submerged crater, with its deep channel leading into it on one side, and the coral Atoll of which we have given figures above (Figs. 1 and 2). Nature has many ways of arriving at apparently analogous results; but close examination shows how varied are her methods.

Sir Charles also points out that, in the quantity of matter ejected, modern eruptions will bear comparison with any we know of in ancient times. In order to help us to realise the enormous volume of the lava poured out from Skaptar Jokul in 1783, he considers "how striking a feature" the two streams of lava then poured out "would now form in the geology of England, had they been poured out on the bottom of the sea after the deposition and before the elevation of our secondary and tertiary rocks." From one we should have a mass 100 ft. thick and 10 to 15 miles broad on the oolitic hills overlooking the vale of Gloucester. It would be traced for a distance of about 90 miles to the neighbourhood of London, where, "crowning the highest sands of Highgate and Hampstead, we might behold some remnants of the current some 500 ft. or 600 ft. in thickness, causing those hills to rival or even to surpass in height Salisbury Craigs and Arthur's Seat" (p. 52); while the other stream might be traced from London to the coasts of Devon and Dorset. The description given (pp. 104-106) of the volcanic outburst in the island of Sumbawa can hardly be read without our feeling that we know of no one ancient volcanic rock comparable in extent to the deposit of ash which must have resulted from the single eruption of 1815.

After having shown that these tremendous effects of volcanic action on the surface are "insignificant when contrasted with the products of heat in the nether regions," Sir Charles says (p. 211):—"The continual transfer of the points of chief development of the earthquake and volcano from one part of the earth's crust to another is established as a general law by the clearest geological evidence. We have also seen that volcanic operations are now in progress on the grandest scale, and also that single currents of lava of modern date are as voluminous as any which can be shown to have ever poured out in the earliest eras to which our geological retrospect can be carried."

The doctrine of the former greater intensity of the igneous forces, connected as it generally was with the hypothesis of the primæval igneous fusion and gradual cooling down of the planet, of course involved the theory of the former higher temperature of the surface of our earth; and therefore all indications of a warmer climate over any area in the ancient seas were supposed to point

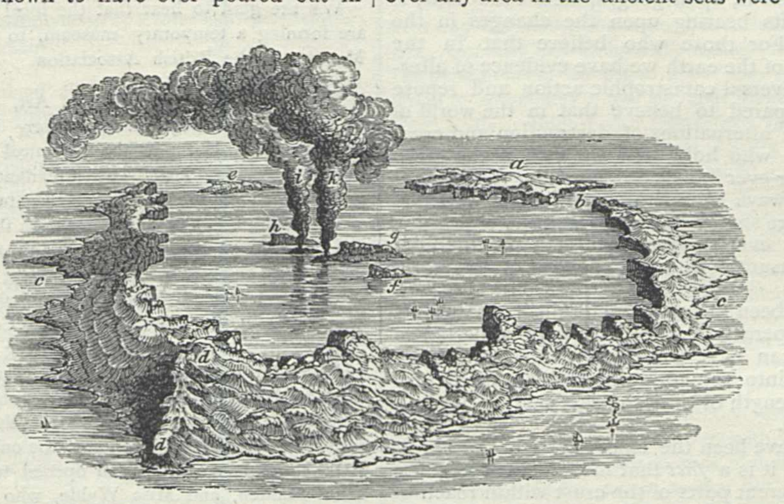


FIG. 3.—BIRD'S-EYE VIEW OF THE GULF OF SANTORIN DURING THE VOLCANIC ERUPTION OF FEBRUARY 1866

a Therasia; *b* the northern entrance, 1,068 feet deep; *c* Thera; *d* Mount St. Elias, rising 1,887 feet above the sea, composed of granular limestone and clay-slate, the only non-volcanic rock in Santorin; *e* Aspronisi; *f* Little Kaimeni; *g* New Kaimeni; *h* Old Kaimeni; *i* Aphroessa; *k* George.

to a universal higher temperature over the globe. But Sir Charles Lyell points out that "the climate of the extra-tropical regions has been by no means always hotter than now; but on the contrary, there has been at least one period when the temperature of those regions was much lower than at present" (p. 173).

Space will not allow us to follow our author while he proves, from an examination of the circumstances under which we find similar and dissimilar climates at the present day, that geographical conditions produce far greater effect upon climate than we have reason to believe would result from any astronomical combinations. Dependent to a great extent upon geographical conditions we have prevalent winds, which materially influence climate, and moreover give rise to most of the great ocean currents.

About the origin of these, however, there has been some controversy. Sir Charles considers the various theories very fully, and shows that the great currents are due to prevalent winds. "That movements," he writes, "of no inconsiderable magnitude should be impressed on a wide expanse of ocean by winds blowing for many months in one direction may easily be conceived, when we observe the effects produced in our own seas by the temporary action of the same cause. It is well known that a strong south-west or north-west wind invariably raises the tide to an unusual height along the west coast of England and in the Channel; and that a north-west wind of any continuance causes the Baltic to rise 2 ft. and upwards above its ordinary level" (vol. i. p. 492).

It is clear that when the surface water is being thus driven continuously for a long time in one direction

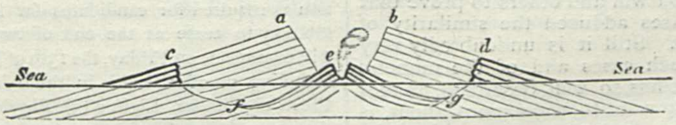


FIG. 4.—SUPPOSED SECTION OF BARREN ISLAND, IN THE BAY OF BENGAL

against a shore or into a *cul de sac*, there must be an undercurrent formed by the head of water thus produced. But in deep basins there is no reason why the water should not remain embayed for ages, and, having been at any time cold, should never receive sufficient from above or below to raise its temperature.

In the Mediterranean and the smaller seas connected with it there seems to be a great complication of current-producing causes, which have proved a fertile source of speculation and controversy ever since Aristotle puzzled over the currents of the Euripus. That land-locked sea is too small to have any considerable tide generated within itself, but the Atlantic tide rushes in and out with great force. The vast surface current of the Atlantic, and the prevailing westerly winds, increase the in-going tide, and check, and generally altogether overpower, the surface part of the out-going tide, so as to give rise to an upper and a lower current in opposite directions through the Straits of Gibraltar.

In addition to these causes, there is the enormous evaporation during the hot season and the excess of fresh water poured in during the rainy season, which must produce a great effect. But as each tide would, when there was a deficiency of water, bring a little more in, and when an excess of water, take a little more out, this adjustment being made twice every day it does not seem likely that either evaporation or rain would make any appreciable difference in the currents at the Straits. Some authors have referred oceanic circulation to difference of specific gravity, due to difference of temperature or amount of salinity; but, though this is a *vera causa* which might in some cases explain similar phenomena, Sir Charles shows, by reference to the observations of Captain Spratt and others, that the currents of the Mediterranean, and, indeed, all observed currents, are due to other causes.

The question of the dependence of climate, both subaerial and sub-aqueous, upon geographical conditions, is very important in its bearing upon the changes in the inorganic world. For those who believe that in the history of the crust of the earth we have evidence of alternate periods of universal catastrophic action and repose would be quite prepared to believe that in the world of life also there were alternations of destruction and creation; but to those who hold that the face of the globe has been, and is for ever being, modified by the gradual action of forces always in operation, it seems *a priori* probable that Nature should have provided the organisms which inhabit this ever-shifting earth with modifiability somewhat commensurate with the changes of the world in which they live.

A mountain has been raised and chiselled out into its present form by operations extending over a period so vast that no one can have witnessed them. A species has been changed into something quite different by processes requiring a length of time so great that no one can have watched them.

Whatever may have been the chief *causes* of the movements of upheaval, it is a *fact* that movements are going on which bring different parts of the crust within reach of denudation, and that, given sufficient time, mountain ranges must be the result.

So, whatever may be the *origin* of the variations, it is a thing definitely known that variations of the same kind as those which are considered to form specific differences do occur; it is a matter of experiment that these variations can be accumulated and perpetuated by selection; it is a matter of observation that Nature does select. The burden of proof that there are any limits to variation or natural selection rests with those who hold it.

It has been objected to the doctrine of the origin of species by natural selection that some totally distinct classes of animals have corresponding organs, so similar that it is difficult to suppose that they can "'have been brought about in two independent instances by merely indefinite and minute accidental variations.' Yet these organs in the two types must have been developed in entire and complete independence one of the other; for it would be impossible to find a common ancestor without going back to some very simple form not yet provided with even the rudiments of vision" (p. 498).

Sir Charles quotes Mr. Darwin and others to prove that in some at least of the cases adduced the similarity of structure was exaggerated. Still it is undoubtedly very great, and the study of such cases and of the mimetic forms which Mr. Wallace has so well described, makes us feel that what we chiefly want to know more about, is the law which governs the first appearance of varieties. Such facts do not so much furnish arguments against the doctrine of the origin of species by natural selection, as in favour of the existence of some law according to which external conditions and the requirements of the individuals may tend to produce variation in a given direction.

How vast and how perplexing are the questions raised by the study of the modern changes of the earth and its inhabitants; but the calm philosophic spirit which pervades the "Principles of Geology" leads us to hope that it may promote in no small degree that education which will render it "possible to welcome new truths," although they may at first appear to be "out of harmony with cherished associations of thought."

T. McK. HUGHES

NOTES

WE are informed that the Directorship of the National Observatory at Marseilles has been offered to Dr. Janssen.

25,000 rupees have already been subscribed towards the Archdeacon Pratt Memorial Fund.

WE are glad to hear that the local committee at Brighton are forming a temporary museum, to be opened during the Meeting of the British Association.

THE prizes in the Faculties of Art, Science, and Fine Arts, of University College, London, were distributed by the Right Hon. S. Cave, M.P., in the Botanical Theatre of that institution on Tuesday last. The attendance was very small, and several even of the professors absented themselves; but, notwithstanding this bad management on the part of the authorities, the proceedings were exceedingly animated and highly interesting to those engaged in the advancement of education. The report of the Dean, Prof. Croom Robertson, showed a very marked improvement in the condition of the College as well as of the School, the number of students during the past session having been greater than in any previous year. Amongst those who distinguished themselves the most notable were four ladies: Miss Orme, who was presented with the first prize and the first certificate for Political Economy, the only class in the Faculty of Arts which has as yet been opened to ladies; Miss Lupton, Miss Malden, and Miss Wylde, who received medals in the Fine Arts Faculty. The third certificate in this class was also taken by a lady; the number in the class being about thirty gentlemen and six ladies. The genuine and enthusiastic applause of the students at these successes leaves nothing to be wished for, except the continuation of that liberal policy for which University College has always been remarkable. Miss Orme had previously greatly distinguished herself at the examinations of the University of London.

THE following telegram has been received at the Admiralty from Aden, dated June 17:—"Dawson and party have returned to Zanzibar, Mr. Stanley having arrived with despatches from Livingstone: alive and well." Letters of that date from Aden are now due.

BESIDES the Minor Scholarships or Exhibitions at St. John's College, Cambridge, there will be offered for competition this year an Exhibition of 50*l*. per annum for proficiency in Natural Science, the Exhibition to be tenable for three years in case the Exhibitioner have passed within two years the previous examination as required for candidates for honours; otherwise the Exhibition to cease at the end of two years. The Examination will commence on Friday, the 13th of December; in (1) Chemistry, including practical work in the laboratory; (2) Physics, viz., Electricity, Heat, Light; (3) Physiology; they will also have the opportunity of being examined in one or more of the following subjects: (4) Geology, (5) Anatomy, (6) Botany, provided that they give notice of the subjects in which they wish to be examined four weeks prior to the Examination. No candidate will be examined in more than three of these six subjects, whereof one at least must be chosen from the former group. It is the wish of the master and seniors that excellence in some single department should be specially regarded by the candidates. They may also, if they think fit, offer themselves for examination in any of the Classical or Mathematical subjects. Candidates must send their names to one of the tutors, Dr. Parkinson, Mr. Bonney, or Mr. Sandys, before the commencement of the Examination. The Minor Scholarships are open to all persons under twenty years of age, whether students in the University or not, who have not yet commenced residence in the University or who are in the first term of their residence. A Minor Scholarship is tenable for two years, or until the scholar is elected to one of the Foundation Scholarships. The Exhibitions are not limited in respect to the age of candidates. It is understood that minor scholars or exhibitioners may be candidates for Sizarships.

THE announcement last week that Mr. E. R. Lankester had gained a Natural Science Scholarship at Exeter College, Oxford, should have read "Fellowship."

THE East London Museum at Bethnal Green was formally opened by the Prince and Princess of Wales on Monday last.

THE Devonshire Association for the Advancement of Literature, Science, and Art, will shortly hold its annual meeting at Exeter, under the presidency of the Bishop of the Diocese.

PROF. HUMPHRY gave his second lecture on "Human Myology" at the College of Surgeons on Wednesday, the 19th. In it he traced the elements of the lateral muscle upon the limbs, forming muscular expansions over them which, he said, were most clearly marked in the rudimentary claw-like limbs of some snakes, but sufficiently distinct in ourselves. In the upper limb, for instance, they form a superficial ventro-appendicular cone, which is divided, sectorially, into the pectoralis, the latissimus dorsi, and the trapezio-deltoid. In the lower limb the corresponding sheet is divided into the gracilis, the gluteus magnus, and the sartorius, with the tensor vaginæ femoris. The deeper layers of the ventro-appendicular cones more closely invest the shoulder and hip-joints. That in the upper limb he divided into the infra-spinatus and teres minor, the coraco-brachialis and subscapularis, and the supra-spinatus; and that in the lower limb he divided into the gluteus medius and minimus, the adductors and obturator, the iliacus and the pyriformis. The professor remarked that the developmental processes are so freely modified in accordance with the special requirements of each limb that an exact homological comparison of the muscles is out of the question; and he showed that the difference in the direction of the rotation of the upper and of the lower limbs upon their respective girdles has been attended with considerable modification of the attachment, especially of the insertion of the several muscles. He spoke of the clavicle as an ossification in one of the intermuscular septa of the ventral muscle, and as, therefore, corresponding serially with the epicostal or "intermuscular" bones developed in the abdominal wall of some lizards. Poupart's ligament belongs to the same series, and spans the crural arch as the clavicle spans the brachial arch. Various points in the disposition of the muscles of the upper parts of the limbs and the purposes served by them were discussed.

SIGNOR G. A. PASQUALE, in a paper presented to the "Accademia delle Scienze fisiche e matematiche" of Naples, attributes the injury done to vegetation by the recent eruption of Vesuvius neither to scorching nor to the mechanical action of the ashes in closing the pores of the leaves, the effect being much more sudden than if due to the latter cause; but to the injurious effects of the chloride of sodium which falls in considerable quantities with the ashes.

THE following account of the recent thunderstorm at Birmingham, by Mr. T. L. Plant, is taken from the *Gardener's Chronicle*:—"Birmingham and vicinity were visited on June 18 by a thunderstorm, accompanied by the most tremendous quantity of rain and enormous pieces of ice, ever registered within my records. The sudden heat after the low temperature in the early part of last week caused the air on the 17th and 18th to become highly surcharged with electricity. On Monday night the heat was intense, lowest thermometer 62°. The rapid increase of temperature will be understood by the following copy of my daily readings from the 12th:—

Highest Temperature in the Shade.

June 12	62°	June 17	86°
„ 13	69°	„ 18	88° (highest temperature recorded in June since 1858
„ 14	77°		
„ 15	80°		
„ 16	82°		

At 12.45 the storm commenced, and lasted three hours and a half. For fully half an hour the rolling thunder was incessant. The depositions of ice began about two o'clock, and during a period of 20 minutes to half an hour there was a fall of large frozen bodies, mingled with tremendous rain, to an extent that finds no parallel in these annals. Some of the pieces of ice (which were of most irregular formation) measured quite an inch in length. During the height of the storm the wind was high and calm in alternate succession, and changing to various points of the compass, and ultimately south, as at first. The fall of rain in this great tempest was 2·47 inches. This is the largest quantity that has been registered in Birmingham, even exceeding the great storm on the evening of July 6, 1845. Most of the rain (which is equal to 250 tons of water to the acre) fell in 45 minutes."

THE School of Science in connection with the Albert Memorial Museum at Exeter shows the zeal with which science is being cultivated in that city. The number of individual students under instruction during the current session has been 67, viz.:—7 in elementary mathematics, 13 in theoretical mechanics, 36 in inorganic chemistry, 9 in vegetable anatomy and physiology, 9 in systematic and economic botany, 7 in physical geography, 4 in machine construction and drawing, and 9 in building construction. The Museum has made considerable progress during the year.

WE have again to notice the increasing success of artizan students at the Oldham School of Science and Art, in practical Inorganic Chemistry; nineteen have passed out of twenty-one examined by the Department.

FROM the Report of the Free Libraries Committee of Birmingham for 1871, we are glad to see that, although the number of volumes in the library bearing on science is small, the demand for them shows considerable interest in these subjects among the frequenters of the library.

THE Committee of Trustees of the Industrial and Technological Museum of Victoria have issued their report for the year 1871. The progress of the Institution is spoken of as having been satisfactory, the number of visitors having greatly increased as well as of objects in the Museum. Illustrations of the mineralogical wealth of our colonies must always be of the highest importance, and there is now in the Museum a collection of the rocks of Victoria, classified and labelled, as well as a large series of fossils from different parts of the country which have not yet been classified. The models of mining machinery, formerly in the University Museum, are now also exhibited in this Museum, forming a most important and complete collection, which has excited great interest among the visitors. The exhibition of vegetable products, illustrative of their industrial uses, is rapidly increasing, and is now being systematically arranged, but is not yet catalogued. The collection of animal products, illustrative of their industrial uses, is very useful and complete. Courses of lectures have been delivered at the Museum, the primary object of which has been to make science in its relation to industry known among the artisan and mechanical classes, and the committee hope that this object has been in some measure attained.

Class lectures for practical instruction and laboratories have also been in operation.

THE circular of the University of Washington for the current year contains a catalogue of the officers and students, and a programme of the course of studies required in the different departments. In these the Physical and Natural Sciences hold a conspicuous place.

THE Deutscher Universitäts-Kalender, by Dr. F. Aschersen, published half-yearly, contains a mass of valuable information respecting all the German universities, including the names of the professors in the several faculties, the subjects for the academical prizes, &c.

WE have on our table the Reports of the Mining Surveyors and Registrars for the Colony of Victoria for the quarters ending June 30, Sept. 30, and Dec. 31, 1871.

THE Report of the Chief Commissioner of Mines for the Province of Nova Scotia for the year 1871 is printed. A report is appended of the Provincial Museum, recently established, and designed to be a permanent exhibition of the industrial resources of the province, combined with a Museum of Science and Art. The mineralogical and zoological departments appear to be well represented.

WE have received the Monthly Record for January of Results of Observations in Meteorology, Terrestrial Magnetism, &c., taken at the Melbourne Observatory, under the superintendence of Mr. R. J. Ellery.

THE American Palestine Exploration Society has, we learn from *Harper's Weekly*, lately received paper squeezes of two basaltic stones inscribed with Phœnician characters similar to, and perhaps companions of, the celebrated Moabite stone of which we have heard so much. The acquisition of the stones themselves has been a subject of much rivalry between the British and American societies; in consequence of which the Arabs, believing them to be extremely valuable, have hidden them, although it is hoped without destroying them, as was done with the Moabite stone. These squeezes were obtained by two well-known Americans, the Rev. D. Stuart Dodge and Frederick S. Winston, and have been forwarded by them to New York. Pen-and-ink copies have already been received, and have lately been lithographed and distributed among American scholars. It is not certain that the stones from which these squeezes were taken are genuine antiquities, the Orientals being unfortunately too well versed in the art of manufacturing such objects, so as to meet any demand. There is, however, a strong probability that they are what they profess to be. At any rate, they will probably before long be subjected to such an examination by experts as will determine their true character.

THE Report just issued of the Proceedings of the Geologists' Association includes detailed accounts of the visits and excursions made by the association during March and April 1871, and Messrs. R. and A. Bell's paper on "The English Crags and their Stratigraphical Divisions."

THE ninth Annual Report of the Wigan Field Naturalists' and Scientific Society contains an important paper by Mr. J. Perrins, on "The Duration of the Wigan Coalfields," illustrated by a coloured section. The Report is otherwise chiefly occupied by accounts of the different excursions of the society.

THE Bury Natural History Society has issued its first Report for the time from its foundation, in January 1868, to December 1871. Its object has been chiefly the investigation of the natural history of the district, which has been pursued with vigour; and the Report contains more or less complete lists of the flowering plants and ferns, lepidoptera, birds, mollusca, fishes, reptiles, and mammalia of the neighbourhood of Bury (the last four classes being somewhat oddly classified as the "animals" of the district).

THE "Verhandlungen der k.k. Zoologisch-botanischen Gesellchaft in Wien," for 1871, contains a number of valuable papers. Among the more important are:—Contributions to a knowledge of the Territelariæ, Thorell (or Mygalidæ), by A. Ausserer; Enumeration of the Cryptogams of Venetia, by Baron v. Hohenbühel-Heufler; Synopsis of the Fishes of the Red Sea, Part II., by Dr. C. B. Klunzinger; Monograph of the genus Certhiola, by Dr. O. Finsch; Monograph of the genus Hylæus, by Prof. Förster.

A PERIODICAL, called the *Economista di Roma*, is now published in Rome, and contains papers upon finance, agriculture, commerce, trades, public works, and statistics.

THE following reprints lie on our table, which we commend to the notice of those interested in the various subjects:—"How Fishes Breathe," by Mr. John C. Galton, from the *Popular Science Review*; "An Account of some Experiments relating to the Influence exercised by Colloids upon the Forms of Inorganic Matter," by Dr. W. B. Ord, from the "St. Thomas's Hospital Reports;" and "Non-existence of Projectile Forces in Nature," by Mr. J. A. Parker, a paper read before the American Institute.

IN a lecture on "The Influence of Human Progress on Medical Education," delivered at the Royal Victoria Hospital, Netley, Dr. W. Aitken gives an interesting sketch of the causes which have led to the improvements in the condition of medical education which have taken place especially within the last fifty years.

AN important ornithological work is announced from America as in the press, to be published by the Naturalists' Agency, Salem, Mass.—"A Key to North American Birds," by Dr. Elliott Coues, to be illustrated by seven steel plates and upwards of 250 woodcuts, and designed as a manual or text-book of the birds of North America.

WE learn from the *Garden* that Dr. Asa Gray, of Cambridge, Massachusetts, the author of "How Plants Grow," and of many important works and papers on botany, has lately brought out another little book, entitled "How Plants Behave," which deals with the climbing and other habits of plants, and is as likely to prove as valuable as the first-mentioned work.

MESSRS. W. and A. K. JOHNSTON have issued "The Edinburgh Sixpenny Quarto Atlas," a marvel of cheapness. It contains sixteen coloured maps, which, though small, are executed in the style with which we are so familiar in the productions of this house.

AS an illustration of the success which generally attends well conducted zoological gardens and aquaria, we may state that, although quite recently organised, the receipts from 216,000 visitors to the aquarium at Berlin for the year 1871 amounted to nearly 40,000 dollars.

WITH reference to the alligator story which we recently printed, Mr. W. C. Easton, who found the nest containing sixty-seven eggs on Eighteen Mile Island, Fitzroy River, on the 31st January last, informs the *Rockhampton Bulletin* that he at that time placed four eggs under a hen, and on visiting the hen's nest on March 14, found two young alligators had broken their shells, and were alive and doing well. They were then of slender form, about ten inches long. Mr. Easton, who is well acquainted with the habits of the alligator, expects his young saurians will be strong enough to bring into Rockhampton for exhibition in the course of a month or six weeks.

ATOMS AND MOLECULES *

THE atomic composition of ponderable matter is a fundamental postulate in the theory of chemical equivalency. By the application of the principles of experimental research, and by methods essentially modern, resulting in the discovery of many elementary bodies and their modes of combination, a conception of very great antiquity has been rendered more distinct and worthy of credence. When this conception took definite form is not known. Indeed, it is one of the many speculations naturally elicited in discussing those subtle questions pertaining to the existence of matter and its relations to mind or spirit, the solution of which has always baffled, and will continue to baffle, the most profound thinkers. In attempting to unfold the mysteries of nature by the deductive process, the ancient teachers of Cosmogony were brought into direct conflict of opinion regarding the ultimate condition of matter. That it is composed of indestructible atoms which admit of no division, seems to have been the notion of some Oriental sages. Under the genius of the Greek philosophy this notion assumed the form and consistency of a theory.

Among those who held the doctrine, while immatured, were Ecphantus, Leucippus, and Democritus. Subsequently Epicurus introduced such modifications and improvements as were essential to its complete development.† The Latin poet Lucretius, in his "De Rerum Naturâ," has given a full exposition of the Epicurean philosophy; from this, as well as from the writings of Plutarch, it will be seen that the most prominent atomic tenets did not differ essentially from the opinions entertained by eminent scientists of modern times.‡ Newton admitted the creation of primitive particles, extremely minute, but permanent. Descartes, on the other hand, held with Aristotle, Plato, and Pythagorae that the division of matter has no assignable limit. Leibnitz attempted to reconcile the conflicting opinions of metaphysicians and mathematicians, by supposing that matter, in its ultimate condition, consists of unextended points which he denominated monads, a term borrowed from Pythagoras. At a later day, Boscovich published his celebrated dynamic theory, in which centres of force are substituted for monads. Neither of these ingenious theories however, reaches the real points of perplexity.

It is obvious that the science which treats of the ultimate composition of bodies would lead to more correct conceptions regarding minute combinations of ponderable matter. Analysis has shown that nearly all the bodies formed in the great laboratory of nature are compounds. Thus far, sixty-three different kinds of matter have resisted every effort to resolve them into simpler constituents. These substances, distinguished as chemical elements, unite in exceedingly minute quantities according to ths well-known laws of Stoichiometry. In the year 1789, Higgins, a professor in the University of Dublin, advanced the idea that certain compounds are formed by the combination of ultimate particles or atoms of different elements. Dalton, in 1803, independently arrived at a similar conclusion, which he generalised, to explain the composition of all compounds, and made it the basis of his "New System of Chemical Philosophy," published five years later. The doctrine of Dalton has undergone, since his day, such modifications as render it more acceptable; but that part of it which ascribes the union of indestructible atoms to chemical affinity may be regarded as the first successful attempt to explain that primordial action which the ancient atomists could not account for, and which the Latin poet above named describes as irregular and fortuitous.*

Chemists of the atomic school happily avoid the vexed question concerning the indivisibility of matter, by defining an atom as the smallest quantity of an element which can enter into the composition of a ponderable molecule; and the molecule, whether made up of one, two, or more elements, as the smallest quantity which can exist in a free state. However, a certain individuality must be assigned to the single atom, for a chemical decomposition requiring its transfer from one molecule to another involves its isolation *in transitu*. The absolute weight of the sixty-three different atoms cannot be ascertained; nevertheless, their relative weights have been determined with great care.

It is difficult to arrive at any clear notions concerning the size of an object so minute as to be for ever invisible under the most powerful magnifier. As an example of the conclusions regarding molecules, founded on microscopic scrutiny, that of the celebrated Ehrenberg may be cited.† Without attempting to make a close approximation towards its actual dimensions, his researches led him to infer that the diameter of an atom (the molecule of the chemist) was considerably less than six millionths of a line. Quite recently Sir W. Thomson, in a paper "On the Size of Atoms,"‡ presented four lines of argument founded on experiments of physicists, which all lead to substantially the same estimate of the dimensions of molecular structure. He says:—

"Jointly they establish, with what we cannot but regard as a very high degree of probability, the conclusion that, in any ordinary liquid, transparent solid, or seemingly opaque solid, the mean distance between the centres of contiguous molecules is less than the hundred-millionth and greater than the two thousand-millionth of a centimetre. To form some conception of the degree of cross-grainedness indicated by this conclusion, imagine a rain-drop, or a globe of glass as large as a pea, to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be coarser grained than a heap of small shot, but probably less coarse grained than a heap of cricket balls."

From these deductions of Thomson some idea may be formed of minute molecular grouping; and I venture the suggestion that, in regard to size, the smallest bullet would probably stand about mid-way between the *glomeramen minimum* and "the great globe itself."

Beyond this point of extreme tenuity, where matter first exhibits that property which is revealed in visible forms, we are forced to consider it in a still more expanded state, as the universally diffused medium of light, heat, and actinism; consequently this conception of the minute ponderable globule does not bring us very near the *minima naturæ*, for a difference in size cannot be less marked between ponderable atoms and those infinitesimal particles forming the luminiferous ether or æth which fills the interstellar spaces, and which, in a more condensed state, probably forms the interatomic medium. Assuming that all forces generating wave motions in elastic fluids follow the same law of propagation, I endeavoured some years ago to estimate the density of this inconceivably attenuated substance.§

In that calculation the density of air is the unit of measure. If instead hydrogen be taken as the unit, the density of luminiferous ether is expressed by the decimal ·00000000001653. Whatever may be its actual density, its reality must be admitted, until the positions established by the investigations of Huyghens,

* Reprinted from the *American Chemist*, corrected by the author.

† Plutarch's "Morals." Edited by Prof. Goodwin, of Harvard University. (Little, Brown, and Co., Boston, Mass.) Vol. viii. pp, 111-112. Vol. v. p. 345.

‡ A full exposition of the ancient atomic philosophy would be foreign to the purpose of this paper. Many of the prevailing erroneous impressions concerning it would, however, be corrected by an examination of the third chapter of Dr. Good's "Book of Nature," in which Epicurus is ably defended against the charge of atheism. Evidently the Epicureans were opposed to Mythology; but while ignoring the power of its gods, they were naturally led to the recognition of a higher Power, an Intelligent Cause, Self-existent, and Supreme. This deduction was reached by the earnest believers in the atomic doctrine. According to Stobæus, Ecphantus supposed the material world to consist of atoms, but yet to be ordered and governed by a Divine providence. Ἔκφαντος ἐκ μὲν τῶν ἀτόμων συνεστάναι τὸν κοσμὸν, διοικεῖσθαι δὲ ἀπὸ προνοίας. Eclog. Physic. lib. 1. cap. xxv. And as evidence of the belief prevalent among wise men several centuries later, Berzelius, in his paper on "Proportions, determinate," quotes from Philo, who, in his collection of the choicest philosophical ideas of his time ("Libri Sapientiæ," cap. xi. v. 22), says:—Πάντα Θεὸς μέτρῳ καὶ ἀριθμῷ καὶ στάθμῳ διέταξε ("God made all things by measure, number, and weight"). This remarkable statement, as far as it relates to things terrestrial, modern chemical investigations have fully confirmed.

* Omnimodis coire, atque omnia pertentare,
Quæcunque inter se possint congressa creare.
Lucret. lib. v. *ver.* 191.

† *Pogg. Annalen.* xxiv., 35.

‡ NATURE, No. 22, vol. i., p. 551.

§ Sound would be propagated, with exactly the velocity of light through a fluid, under the standard pressure, 874,094,104,900 times rarer than air. Therefore, if the density of air be 1, the density of æth is represented by the decimal ·000,000,000,001,144+.

It will not be inferred from this view that the aim has been to reach

"The first of things, quintessence pure,"

for the elastic quality of æth involves the hypothesis of a still more subtle fluid. We have raised one curtain only to find another to be raised. As the unfathomed vaults of Heaven recede before the sweep of a more powerful refractor, and nebulæ resolved reveal nebulæ beyond, so the most diminutive germ that springs from the Creator's touch discloses through the lens of higher power new signs of more wonderful mechanism within. Each nucleus has its nuclei! Each entoblast is but the boundary of a microcosm! Each particle a galaxy of atoms revolving in the all-pervading æth! Thus, before every far-reaching human advance, *Circumference* and *Centre* will for ever retreat.—*Transactions of the American Institute*, 1864, p. 539. ("Clydonics," No. 1)

Young, Fresnel, Foucault, and Fizeau, are shown to be untenable. A very able American metaphysician, in meeting an objection brought by Huxley against the views of Comte, has strongly expressed his unqualified dissent;* nevertheless, the hypothesis that light, heat, and actinism are propagated by the undulations of a subtle all-pervading fluid, is the only one which satisfactorily accounts for a certain class of phenomena, and it is accepted by all the prominent experimental physicists of the present day.

The vast difference in density indicated cannot be apprehended, because numerical comparisons utterly fail to raise in the mind any clear conception regarding a fluid so attenuated; yet it naturally suggests the idea that there must be many intervening conditions of matter in which it exists in successive degrees of increasing density, and that these conditions form the connecting links, so to speak, between its apparently imponderable and its ponderable states. Something like this opinion seems to have been maintained in a curious work published in England many years ago.† The reverend author, viewing the universe as a systematic manifestation of the Divine Will, assumes that the medium of light is the mother element from which by progressive steps the chemical elements have been evolved. Proceeding from the first lines of morphology he arrives at the primitive form which cannot be isolated; then by an exceedingly ingenious synthetic process he represents by diagrams his ideal structure of different kinds of atoms, all of which are duplications of the tetrahedron. Thus he claims to reveal the unit, by multiples of which the atomic weight of all chemical elements may be expressed, and so arrives at a result which will be recognised as simply a modification of the so-called law of Prout. Although this, and other remarkable surmises by Macvicar are, for reasons which need not here be adduced, quite untenable, he seems to have led the way to an assumption which has recently met with some favour, namely, that the chemical atom, although indivisible, is a collection of smaller particles. However, in following this author towards the infinitesimal, we only realise more fully the truth that above and below the narrow zone of the visible are objects too far off and too fine for human scrutiny. Although the *seeming all* is rounded by intimation of other and brighter regions, Science can never compass them by any extension of her domain! In those unsounded depths which form the boundary and background of the known, thought grown dizzy finds no support; and even the positivist turns back bewildered when mensuration fails and computations end in surds!

On examining the numerous works on chemistry published within the last twenty years, one cannot fail to notice a gradual change in the expressions employed in describing reactions. The word "equivalent" seems to have lost the meaning originally assigned to it by Wollaston, and the terms "combining weight" and "combining proportion" are now used less frequently than "atomic weight" and "atom." This abandonment of old forms of expression doubtless indicates a gradual change of opinion among leading chemists, a change which may be ascribed partly to an accumulation of facts tending to confirm the atomic theory, and, partly, to the promptings of that mysterious intuition which, overleaping the limits of logic, often arrives at correct conclusions even before their truth has been demonstrated.

During all the discussions on "atomicity" hardly a doubt has been raised as to the actual existence of the atom. It was not, therefore, surprising that the chemical world received a sensible shock at the stand made by Brodie in 1868.‡ However, a careful examination of his paper is likely to lead to the conclusion that the objections to the atomic theory therein enumerated are not more formidable than those which can be urged against his own ingenious, but complicated method of chemical operations. Precision in signs and definitions leads to exact results in the abstract, nevertheless a mathematical formula often requires modification to meet the varying conditions found in actual practice, and even then it only gives a near approximation to the truth.

Renewed attention to this subject was doubtless the means of drawing from the then President of the London Chemical Society a paper "on the Atomic Theory," which is generally regarded as the best exposition and defence of the doctrine yet made, and which may be consulted with profit by those desiring to obtain a

* Eleventh Harvard lecture, by Prof. John Fiske. Cambridge, Mass., 1869.

† "Elements of the Economy of Nature." By J. G. Macvicar, D.D. (London: Chapman and Hall.) 1856.

‡ "The Calculus of Chemical Operations." By Prof. B. C. Brodie. *Journal of the Chemical Society*, London, vol. xxi. p. 367.

clear statement of the principal results of chemical research adduced for its confirmation.*

A vigorous attack on the atomic theory has since been made by Mills, the real tendency of which is to raise doubts concerning the existence of matter itself.† He quotes with evident satisfaction from a work by Digby "on the nature of bodies" printed in 1645, wherein *quantity* is defined "as but one whole that may indeed be cut into so many several parts; but those parts are really not there till by division they are parcelled out; and then the whole (out of which they are made) ceaseth to be any longer, and the parts succeed in lieu of it, and are every one of them a new whole." From this statement proceeds a train of geometrical reasoning concerning extension and division which leads to the old dilemma regarding finite and infinite indivisibles.

Fortunately a new science, unknown to Digby, has demonstrated that matter has other than mere physical properties which are so clear and well defined as to enable its votaries to determine the ultimate composition of all bodies. The chemist affirms that, however inclined we may be to regard a body as a whole, it is in fact composed of minute parts which may be separated, and that in the great majority of bodies, which are compounds, Nature has herself made divisions by incorporating unlike parts which may be replaced by other unlike parts. On questions relating to the actual size of these parts, their form, their structure, &c., he makes no issue; he simply asserts that all these ultimate parts are permanent, and that those composed of the same kind of matter are identical in size and structure. The limits proposed for this paper will permit elucidation of this point alone.

The clearest conception of molecules and atoms will be arrived at by examining the principal phenomena attending the mechanical mixture and final chemical union of the lightest and the heaviest of the simple gases. The electro-positive element, hydrogen, is a permanently elastic gas, having a relative density expressed by 1. Its properties are in marked contrast with those of chlorine, a yellowish green gas, which may be condensed into a liquid, by a pressure of about four atmospheres. The density of this strong electro-negative element is 35·5. If two vessels of equal capacity, filled with these gases respectively, be placed in the dark, one over the other, and a communication be opened between them, a mutual diffusion of the gases will commence, the relative velocity being inversely as the square root of their densities. The action continues untraversed by the force of gravitation until minute portions of hydrogen and chlorine are equally diffused throughout both receptacles. This phenomenon cannot be accounted for, excepting on the supposition that minute parts of each gas have undergone complete isolation. If diffusion were effected only through a single stratum or extremely thin layer, it would be possible for two gaseous elements to retain their continuity by passing each other in intertwining streams, thus forming like threads, a warp and woof; but when diffusion is in every direction it is obvious that these elements must positively separate each other, and thus be divided into extremely diminutive bodies each of the same dimensions. Let l represent the lighter gas, d the denser, and e the dimensions or size of each isolated portion, then el and ed will denote the dissimilar parts of which the whole gaseous matter is composed. As the phenomenon of diffusion occurs under the conditions mentioned, whatever may be the quantity of gases employed, it follows that el and ed are individual volumes or molecules, invariably of the same dimensions. This diffusion of gases may therefore be defined as the uniform intermingling of dissimilar molecules.

If the molecules el and ed thus commingled while in the dark be exposed to direct sunlight, an instantaneous and complete chemical combination occurs with explosive violence but without condensation; or if exposed to diffused daylight, the union of elements will be gradual and without explosion; the resulting compound in each case being hydrochloric acid gas.

The affinity or force of chemism is generated by the action of light on the coloured gas chlorine, which, by absorbing all the rays and transmitting only the yellowish green, acquires a power which seems to be expended by the union of that element with hydrogen. Early in the present century M. Benard announced that the new properties acquired by chlorine on exposure to light were derived from the violet ray. In 1843 Draper proved by experiment the relative power of each ray in producing this

* "On the Atomic Theory." By Prof. A. W. Williamson. *Jour. Chem. Soc.* London, vol. xxii. p. 328

† "On the Atomic Theory." By Edmund J. Mills, D.Sc. *Philosophical Magazine*, vol. xlii. No. 278, p. 112.

change, the actinic rays being altogether the most effective.* Mr. E. Budde has recently described a remarkable experiment in this direction. He found that a differential thermometer filled with chlorine expanded about seven times more in the violet than in the red ray of the solar spectrum; when the same thermometer was filled with CO_2 no action was noticed.†

As the combination of hydrogen and chlorine is effected without change of volume, it is obvious that the molecule *el* does not unite with the molecule *ed*, forming a compound molecule *el-ed*. The conclusion is therefore unavoidable that each molecule has been divided into two equal parts, and that by affinity, like parts have been separated, and unlike parts have been united. These parts are the smallest quantities that can be isolated, and are in fact the atoms recognised by the chemist. If this smallest combining proportion or atom be designated by *a*, the actual composition of the hydrogen molecule *el*, weighing 2, may be clearly represented by *al-al* (weight 1 + 1), and the chlorine molecule *ed* weighing 72, by *ad-ad* (weight 35·5 + 35·5). As the attraction of *al* to *al*, and of *ad* to *ad* is, after exposure to light, less than of *al* to *ad*, there is an instantaneous chemical change by which one molecule of hydrogen and one molecule of chlorine are transformed into two molecules of hydrochloric acid gas. This reaction is clearly indicated by the following equation: *al-al* + *ad-ad* = *alad* + *alad* = 2 *alad*.

The symbols here used are intended to convey to the mind an idea of the relative size of combining parts, which is not so apparent when expressed as follows:—

$$H_2 + Cl_2 = HCl + HCl = 2\,HCl.$$

From the simplest of molecular types we might proceed to the most complex; and, throughout, if we consider the combining proportion of each simple constituent as either a unit or a multiple of a unit, the composition of each molecule may be expressed by whole numbers. Thus having as many different kinds of units as there are elements, any true chemical combination may be symbolised by a combination of arithmetical ratios. This method, under the light of the atomic theory, clearly reveals the harmonic relations of molecular constituents, which, seen from the stand-point of percentage composition, appear unconnected and discordant.

It must be admitted that many of the reactions of well-known bodies have not yet been determined quantitatively; yet were they made out, we should not be able to demonstrate by experiment the truth of the atomic doctrine. It still remains a theory, in favour of which there are many facts and phenomena that collectively form an argument not easily to be outweighed. This evidence may be briefly summarised as follows:—

1. *Atomic Weights.* Elements combine in extremely minute parts, according to the law of definite and multiple proportions. The atomic weight of an element is either its equivalent weight or a multiple of it, as such multiple cannot be divided by reactions, its weight must conform with the atomic number. Whatever changes of position the combining weight of an element may undergo in a series of molecular metamorphoses, that is to say, however many times it may be displaced and replaced in chemical combinations, it invariably retains its characteristic weight. This invariability of weight is an essential property of the atom.

2. *Atomic Volume.* Gases unite in equal volumes or multiple volumes. If hydrogen be taken as unity, the density of each elementary gas is identical with the weight of its atom. The atomic volume, determined by dividing the atomic weight of a body by its specific gravity, has been the means of revealing many interesting relations among compounds of similar structure, and among many containing different components and of unlike structure.

3. *Atomic Heat.* It has been shown by experiment that quantities of each element conforming with its atomic number have the same capacity for heat, excepting only carbon, boron, and silicon; these, it is believed, will yet be found to conform to the law, that the specific heats of atoms are the same. This law is regarded as a direct confirmation of atomic weights.

4. *Molecules.* According to the atomic theory chemical forces are brought in equilibrium when atoms combine and form a molecule. Every gas and every vapour undecomposed has a density proportional to its molecular weight. All known molecular combinations and combining proportions are in accordance with the atomic doctrine. Decomposition by electrolysis affords some evidence that the constituent parts of a molecule which are simultaneously separated are proportionate to atomic weights.

5. *Atomic combining capacity.* The modern doctrine of types and substitutions is solely based on the individuality of the atom, without which the whole fabric of typical structures must fall.

6. *Isomerism.* The fact that bodies containing the same elements, and in precisely the same proportions, exhibit different properties, has been thus far accounted for, only on the supposition that atoms are differently arranged in each body. These differences in arrangement depend not only on the relative position of atoms, but also on the order as to time in which they combine; for two or more atoms having such precedence over others as to combine first, may, by that means, form a radical of such permanence as to play the part of an atom. Apart from the question of radicals, we may ascertain the number of different bodies which can be formed from the same number of different atoms, by an application of the mathematical law of permutations.

7. *Homogeneity.* The uniformity of structure and appearance of any element or chemical combination of elements furnishes the most palpable proof of the identity in size and shape of those definite parts which we designate as molecules. This homogeneity is retained under different degrees of pressure, thus making it apparent that molecules are not identical in structure, but that they approach and recede in precisely the same manner under the same conditions.

Finally.—The foregoing statement regarding the existence of atoms which are indivisible and indestructible under the present order of things does not preclude the supposition that the atom may be a cluster of smaller particles held together by a powerful affinity, which, when counteracted, would leave them free to move within a given sphere. On this assumption it is highly probable that the relative position of such particles may modify the combining capacity of the atom. Moreover, the normal motion of such particles may determine not only the peculiarities of elemental spectra, but produce other effects not dependent on the amplitude of atomic oscillations, thus favouring the inference that the atom itself is a receptacle of force.

SAMUEL D. TILLMAN

* A Treatise on the Forces which produce the Organisation of Plants. By John William Draper. (New York: Harper and Brothers, 1843.)

† *Pogg. Annalen* for 1871, No. 10.

BLOOD-RELATIONSHIP *

I PROPOSE in this memoir to deduce by fair reasoning from acknowledged facts a more definite notion than now exists of the meaning of the word "kinship." It is my aim to analyse and describe the complicated connection that binds an individual, hereditarily, to his parents and to his brothers and sisters, and, therefore, by an extension of similar links, to his more distant kinsfolk. I hope by these means to set forth the doctrines of heredity in a more orderly and explicit manner than is otherwise practicable.

From the well-known circumstance that an individual may transmit to his descendants ancestral qualities which he does not himself possess, we are assured that they could not have been altogether destroyed in him, but must have maintained their existence in a latent form. Therefore each individual may properly be conceived as consisting of two parts, one of which is latent and only known to us by its effects on his posterity, while the other is patent and constitutes the person manifest to our senses.

The adjacent, and, in a broad sense, separate lines of growth in which the patent and latent elements are situated, diverge from a common group and converge to a common contribution, because they were both evolved out of elements contained in a structureless ovum, and they jointly contribute the elements which form the structureless ova of their offspring.

The annexed diagram illustrates my meaning, and serves to show clearly that the span of each of the links in the general chain of heredity extends from one structureless stage to another, and not from person to person.

Structureless elements in Father	{ ......Adult Father ...... } { ......Latent in Father...... }	Structureless elements in offspring.

I will now proceed to consider the quality of the several relationships by which the above terms are connected together.

The observed facts of Reversion enable us to prove that the latent elements must be greatly more varied than those that are personal or patent. The arguments are as follows:—(1) There

* Read before the Royal Society, June 13, by Francis Galton, F.R.S.

must be room for very great variety, because a single strain of impure blood will reassert itself after more than eight generations; (2) an individual has 256 progenitors in the eighth degree, if there have been no ancestral intermarriages, while under the ordinary conditions of social and neighbourly life, he will certainly have had a considerable, though a smaller, number of them; (3) the gradual waning of the tendency to reversion as the generations increase, conforms to what would occur if each fresh marriage contributed a competing element for the same place, thus diluting the impure strain until its relative importance was reduced to an insignificant amount. It follows from these arguments that for each place among the personal elements there may exist, and probably often does exist, a great variety of latent elements that formerly competed to fill it.

I have spoken of the primary elements as they exist in the newly-impregnated ovum, where they are structureless, but contain the materials out of which structure is evolved. The embryonic elements are segregated from among them. On what principle are they segregated? Clearly it is on some principle whose effects are those of "Class Representation," using that phrase in a perfectly general sense, as indicating a mere fact, and avoiding any hypothesis or affirmation on points of detail, about most, if not all, of which we are profoundly ignorant. I give as broad a meaning to the expression as a politician would give to the kindred one, a "representative assembly." By this he means to say that the assembly consists of representatives from various constituencies, which is a distinct piece of information so far as it goes, and is a useful one, although it deals with no matter of detail; it says nothing about the number of electors, their qualifications, or the motives by which they are influenced; it gives no information as to the number of seats; it does not tell us how many candidates there are usually for each seat, nor whether the same person is eligible for, or may represent at the same time, more than one place, nor whether the result of the elections at one place may or may not influence those at another (on the principle of correlation). After these explanations there can, I trust, be no difficulty in accepting my definition of the general character of the relation between the embryonic and the structureless elements, that the former are the result of election from the latter on some method of Class Representation.

The embryonic elements are *developed* into the adult person. "Development" is a word whose meaning is quite as distinct in respect to form, and as vague in respect to detail, as the phrase we have just been considering; it embraces the combined effects of growth and multiplication, as well as those of modification in quality and proportion, under both internal and external influences. If we were able to obtain an approximate knowledge of the original elements, statistical experiences would no doubt enable us to predict the average value of the form into which they would become developed, just as a knowledge of the seeds that were sown would enable us to predict in a general way the appearance of the garden when the plants had grown up. But the individual variation in each case would be great, owing to the large number of variable influences concerned in the process of development.

The latent elements in the embryonic stage must be developed by a parallel, I do not say by an identical process, into those of the adult stage. Therefore, to avoid all chance of being misapprehended when I collate them, I will call, in the diagram I am about to give, the one process "Development (*a*)" and the other "Development (*b*)."

It is not intended to affirm, in making these subdivisions, that the embryonic and adult stages are distinctly separated; they are continuous, and it is impossible but that they should overlap, some elements remaining embryonic while others are completely formed. Nevertheless the embryo, speaking broadly, may fairly be looked upon as consecutive.

Again, the two processes are not wholly distinct; on the contrary, the embryo, and even the adult in some degree, must receive supplementary contributions derived from their contemporary latent elements, because ancestral qualities indicated in early life frequently disappear and yield place to others. The reverse process is doubtful; it may exist in the embryonic stage, but it certainly does not exist in a sensible degree in the adult stage, else the later children of a union would resemble their parents more nearly than the earlier ones.

Lastly, I must guard myself against the objection, that though structure is largely correlated, I have treated it too much as consisting of separate elements. To this I answer, first, that in describing how the embryonic were derived from the structureless elements, I expressly left room for a small degree of correlation; secondly, that in the development of the adult elements of the embryonic, there is a perfectly open field for natural selection, which is the agency by which correlation is mainly established; and thirdly, that correlation affects groups of elements, and not the complete person, as is proved by the frequent occurrence of small groups of persistent peculiarities, which do not affect the rest of the organism, so far as we know, in any way whatever.

The ground we have already gained may be described as follows:—

Out of the structureless ovum the embryonic elements are taken by Class Representation, and these are developed (*a*) into the visible adult individual. On the other hand, returning to our starting-point at the structureless ovum, we find, after the embryonic elements have been segregated, the large residue is developed (*b*) into the latent elements contained in the adult individual. All this is summarily expressed in the first two columns of the diagrams below. I might have inserted vertical arrows to show the minor connections between the corresponding stages in the two parallel processes, but it would have complicated the figure.

In what way do the patent and latent adult elements respectively contribute representatives towards the structureless stage of the next generation? We know that every quality they possess may be transmitted to it, but it does not follow that they are invariably transmitted. The contributions from the patent elements cannot be by "Class," because their own original elements have been themselves specialised, and therefore can contain no more than one or a few members of each class (which, it is true, must have been somewhat developed, both in numbers and variety). Their contributions may therefore be justly described as being effected on some principle that has resulted in a "Family representation," though whether in a strictly universal representation I do not profess to say.

As regards the large variety of adult latent elements, they cannot all be transmitted, for the following obvious reason; the corresponding qualities of no two parents can be considered exactly alike; therefore the accumulation of sub-varieties, if they were all preserved, as the generations rolled onwards, would exceed in multitude the wildest flights of rational theory. The heritage of peculiarities through the contributions of 1,000 consecutive generations, even supposing a great deal of ancestral intermarriage, must far exceed what could be packed into a single ovum. The contributions from the latent adult elements are therefore no more than representative; but we know they cannot be so on the broad principle of "class representation," if the word "class" be applied to the same large orders as before, and if the representatives are few in number, because it is incumbent on them to furnish all the various members of each Class whence the representatives have to be drawn. Therefore, bearing in mind what has been just argued, that it is impossible for the elements of every individual quality to be contributed, we are driven to suppose, as in the previous case, a "Family Representation," the similar elements contributed by the two parents ranking, of course, as of the same family. It is most important to bear in mind that this phrase states a fact and not an hypothesis; it does not mean that each and every Family has just one representative, for it is absolutely reticent on all matters of detail, such as those I enumerated, when speaking of Class Representation. To show the importance which I attach to this disclaimer, I may be permitted to mention what appears to me the most probable *modus operandi*, namely, that it is in reality a large selection made on a broader and not a narrower system than that of classes, and similar to that obtained by an indiscriminate conscription; thus, if a large army be drawn from the provinces of a country by a general conscription, its constitution, according to the laws of chance, will reflect with surprising precision the qualities of the population whence it was taken; each village will be found to furnish a contingent, and the composition of the army will be sensibly the same as if it had been due to a system of immediate representation from the several villages.

The following diagram expresses the whole of the foregoing results:—It begins with the structureless elements, whence the parent individual was formed, and ends with its contributions to the structureless elements, whence his offspring is formed.

I will now inquire, what are, roughly speaking, the relative proportions of the contributions to the elements of the offspring made respectively by the patent and latent elements of the adult parent? It is better not to complicate the inquiry by speaking, at first, of these elements in their entirety, but rather of some special characteristic; thus, to fix the ideas, suppose we are speaking about a peculiar skin-mark in an animal. The peculiarity in question may be conceived (1) as purely personal, without the concurrence of any latent equivalents, (2) as personal but conjoined with latent equivalents, and (3) as existent wholly in a latent form. It can be shown that, in the first case, the power of hereditary transmission is exceedingly feeble, for notwithstanding some exceptions (as in the lost power of flight in domestic birds), the effects of the use and disuse of limbs, and those of habit, are transmitted to posterity in only a very slight degree. Again, it can be fairly argued that many classes of cases which seem at first sight to fall under case (1), that is, to be purely personal, and to prove a larger hereditary influence than what I assign to it, do really belong to case (2). Thus, when individuals born with a peculiar mark are reputed to be the first of their race in whom it had ever appeared, it would be hazardous in the extreme to argue that the latent elements of that mark were wholly deficient in them. It is very remarkable (I was indebted for a knowledge of this fact to Mr. Tegetmeier) how nearly every bar or spot found in any species of an animal in its wild state may be bred into existence in the domesticated variety of that species; showing that the elements of all these bars and spots are universally present in all varieties of the species, though their manifestation may be overborne and suppressed. We therefore see that the hereditary influences of an animal with respect to any particular spot are, I will not say in every case, but certainly on the average of many cases, much more numerous than if that spot had been purely a personal characteristic, without the concurrence of any latent elements. Bearing this argument in mind, we shall more justly estimate the import of the statistical evidence to be obtained from breeders of animals. I should judge from the impression left by many scattered statistics that it is perfectly safe to affirm that breeders, when they mate two animals, each having the same unusual characteristic, not through known hereditary transmission, but by supposed variation, would consider themselves fortunate if one quarter of the progeny inherited that quality. Now these successful cases are, as I have shown, on the average, the produce of parents having the peculiarity not only in a personal, but also, to some degree, in a latent form. We may therefore reasonably conclude that, had the latter portion been non-existent, the ratio of successful cases would have been materially diminished.

I should demur on precisely the same grounds to objections based on the fact of the transmission of qualities to grandchildren being more frequent through children who possess those qualities than through children who do not; for I maintain that the personal manifestation is on the average, though it need not be so in every case, a certain proof of the existence of some latent elements.

Having proved how small is the power of hereditary transmission of the personal elements, we can easily show how large is the transmission of the purely latent elements, in the case (3) by appealing to the well-known facts of reversion; but into these it is hardly necessary for me to enter at length. The general and safe conclusion is that the contribution from the patent elements is very much less than from the latent ones.

If we now combine our results into a single diagram, showing the fainter stream of heredity by *italic lines*, and indicating those processes by asterisks (*) which were described at length in the previous figure, we shall easily recognise the complexity of hereditary problems. We see that parents are very indirectly

Structureless elements of parent . .	through "Class-Representation" afford	Embryonic elements . . .	which by "Development" (*a*) become	Adult elements	which by "Family Representation" contribute to .	Structureless elements of offspring.
	"Residue" after the abstracted elements are	Latent elements in embryo	which by "Development" (*b*) become	Latent elements in adult . .	which by "Family Representation" contribute to .	

Structureless elements of father	* *Embryonic*	* *Adult FATHER* *	Structureless elements of offspring . . .	* Embryonic * Adult OFFSPRING.
	* Latent in embryo	* Latent in adult * father		. . . . . .
Structureless elements of mother	* *Embryonic*	* *Adult MOTHER* *		
	* Latent in embryo	* Latent in adult * mother		

and only partially related to their own children, and that there are two lines of connection between them, the one of large and the other of small relative importance. The former is a collateral kinship and very distant, the parent being descended through two stages (two asterisks) from a structureless source, and the child (so far as that parent is concerned) through five totally distinct stages from the same source. The other, but unimportant line of connection, is direct, and connects the child with the parent through two stages. We shall therefore wonder that, notwithstanding the fact of an average resemblance between parent and child, the amount of individual variation should not be much greater than it is, until we have realised how complete must be the harmony between every variety and its environments, in order that the variety should be permanent.

We also infer from the diagram how near, and yet how subject to variation, is the kinship between the children of the same parents; for only two stages are required to trace back their descent to a common origin, which, however, proceeds from four separate streams of heredity, namely, the adult patent and latent elements of each of the two parents.

An approximate notion of the nearest conceivable relationship between a parent and his child may be gained by supposing an urn containing a great number of balls, marked in various ways, and a handful to be drawn out of them at random as a sample. This sample would represent the person of a parent. Let us now suppose the sample to be examined, and a few handsful of new balls to be marked according to the patterns of those found in the sample, and to be thrown along with them back into the urn. Now let the contents of another urn, representing the influences of the other parent, to be mixed with those of the first. Lastly, suppose a second sample to be drawn out of the combined contents of the two urns, to represent the offspring. There can be no nearer connection justly conceived to subsist between the parent and child than between the two samples; on the contrary, my diagram shows the relationship to be in reality much more remote, and consisting of many consecutive stages, and therefore hardly to be expressed by such simple chances. Whenever the balls in the urns are much of the same pattern, the samples will be alike, but not otherwise. The offspring of a mongrel stock necessarily deviate in appearance from each other and from their parents.

We cannot now fail to be impressed with the fallacy of reckoning inheritance in the usual way, from parents to offspring, using those words in their popular sense of visible personalities. The span of the true hereditary link connects, as I have already insisted upon, not the parent with the offspring, but the primary elements of the two, such as they existed in the newly impregnated ova whence they were respectively developed. No valid excuse can be offered for not attending to this fact, on the ground of our ignorance of the variety and proportionate values of the primary elements. We do not mend matters in the least, but we gratuitously add confusion to our ignorance, by dealing with hereditary facts on the plan of ordinary pedigrees—namely, from the persons of the parents to those of their offspring.

It will be observed that, owing to the clearer idea we have now obtained of the meaning of kinship and of the consecutive phases of the chain of life, the various causes of individual variation can be easily and surely sorted into their proper places. I will mention a few of them, merely as examples.

In the segregation of the embryonic elements, if the structureless ones be diverse without any strongly preponderating element, it is impossible to foresee the character of the embryo, just as it is impossible to foresee the character of a handful chosen from an urn containing a mixed assemblage of variously coloured balls. But if they be not diverse, then the embryonic elements will be a true sample of the structureless ones, the conditions of purity of blood are fulfilled, and the offspring will resemble its parents.

We also see, in the process by which the embryonic elements are obtained, how the curious phenomenon may occur of inheritance occasionally skipping alternate generations. The more that has been removed from the structureless group for the supply of the embryonic (which as we have seen, in a nearly sterile destination) the less remains for the latent group, too little, it may be, to assert itself by that, the only prolific, line of transmission. In the supposed case it would recuperate itself during the succeeding generation, where the elements in question will have remained wholly latent, owing to their insignificance in the structureless stage of that generation, which would be sufficient to secure any portion of it from selection for the embryonic form.

It is in the stage of development where I presume those influences to come in, which cause domesticated animals, when turned loose, to become feral. No variety can be stable unless the conditions of development concur to maintain the structureless stages of consecutive generations in an unchanged form. It is clearly of no avail to a breeder to obtain a stock by continued and careful selection, that shall conform to a desired type, if the animals be afterwards reared under other conditions, by which the subsequent stages, both latent and patent, shall be modified.

Lastly, it is in the process of selection of elements, both latent and patent, from the adult parents for the structureless stage of the next generation, where I suppose the curious and unknown conditions usually to occur, through which a change in the habits of life, after the adult age has been reached, is apt to produce sterility. I may be permitted to remark, hypothetically, that this view appears to be corroborated by the fact, that many grains of pollen or many spermatozoa are required to fertilise each ovum, because, as it would seem, each separate one does not contain a sufficiently complete representation of the primary elements to supply the needs of an individual life, and that it is only by the accumulation of several separate consignments (so to speak) of the representative elements, that the necessary variety is ensured. I argue from this that there is a tendency to a large individual variation in the constituents of each grain of pollen, or spermatozoön, and, by analogy, that there is a similar though smaller tendency in each ovum. Also, that changes in the habits of life may increase this variation to a degree that involves sterility.

One result of this investigation is to show very clearly that large variation in individuals from their parents is not incompatible with the strict doctrine of heredity, but is a consequence of it wherever the breed is impure. I am desirous of applying these considerations to the intellectual and moral gifts of the human race, which is more mongrelised than that of any other domesticated animal. It has been thought by some that the fact of children frequently showing marked individual variation in ability from that of their parents, is a proof that intellectual and moral gifts are not strictly transmitted by inheritance. My arguments lead to exactly the opposite result. I show that their great individual variation is a necessity under present conditions, and I maintain that results derived from large averages are all that can be required, and all we could expect to obtain, to prove that intellectual and moral gifts are as strictly matters of inheritance as any purely physical qualities.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, June 20.—Dr. Frankland, F.R.S., president, in the chair. The president announced that Mr. Hyde Hills had given ten guineas to the fund for promoting original research, and promised to further increase the donation by ten guineas for each ninety subscribed for the same purpose.—Mr. H. Deacon, on "Deacon's Method of Obtaining Chlorine, as Illustrating some Principles of Chemical Dynamics." The process consists in passing a heated mixture of air and hydrochloric acid over sulphate of copper, or over pieces of pumice or brick saturated with the same. He finds that the action is essentially a surface action, and that there is a certain comparatively small range of temperature, between the critical limits of which the percentage of hydrochloric acid decomposed varies greatly. The velocity with which the mixed gases pass over the surface of the active material also causes considerable variation in the comparative amount of chlorine produced.

BOOKS RECEIVED

ENGLISH.—As Regards Protoplasm, new edition: J. H. Stirling (Longmans).

AMERICAN.—The Periodic Law: Rev. G. A. Leakin.

FOREIGN.—Rendiconto dell'Accademia delle Scienze fisiche et matematiche, Naples, 1862-1869 (through Williams and Norgate).—Compendium der physiologischen Optik für Mediciner u Physiker: Dr. H. Kaiser.

PAMPHLETS RECEIVED

ENGLISH.—How Fishes Breathe: J. C. Galton.—Influence of Colloids on Inorganic matter: W. Ord.—The Edinburgh Sixpenny 4to. Atlas: W. and A. K. Johnston.—The Insulation of St. Michael's Mount: W. Pengelly.—The Sidereal and Solar Systems: C. C. Clarke.—The Influence of Human Progress on Medical Education: W. Aitken.—Influence of Vaccination, &c., on Mortality from Small-Pox: R. Grieve, M.D.—London Students' Gazette, May.—Annual Address to the Linnean Society: G. Bentham.—Transactions of the Norfolk and Norwich Naturalists' Society, 1872.—Meetings of the Newcastle-on-Tyne Chemical Society, 1871-2.—Journal of the Iron and Steel Institute, vol. i No. 2.—Report of the Astronomer Royal to the Board of Visitors.—Quarterly Journal of the Meteorologieal Society, vol. i. No. 2.—Journal of Anatomy and Physiology, No. 10.—Proceedings of the Geologists' Association, vol, ii. No. 5.—Tenth Annual Report of the Birmingham Free Libraries Committee, 1871.—Report of Wigan Field Naturalists' Society, 1870-72.—Quarterly Weather Report of the Meteorological Office, Oct. to Dec., 1870.—Devon and Exeter Albert Memorial Museum School of Science and Art; Report for 1872.—Transactions of the Institute of Engineers in Scotland.—Report of Bury Natural History Society, 1872.—On Phonic Coast Fog-Signals: A. Beazeley.—Examination of the recent Attack upon the Atomic Theory: R. W. Atkinson.—The Mining Review, vol. i. No. 8.

AMERICAN AND COLONIAL.—The American Practitioner, May 1872.—Reports of the Mining Surveyors and Registrars, Victoria.—Report on the Operations of the Trigonometrical Survey of India, 1870-71: Major Montgomerie.—Second Annual Report on the injurious and beneficial Insects of Massachusetts: A. S. Packard.—Historical Sketch of the *Public Ledger* of Philadelphia: E. H. Munday.—Monthly Record of Observations in Meteorology and Terrestrial Magnetism: R. J. Ellery.—The Projected Science Association for the Natives of India, Mahendra la 'l Sircár, M.D.—Report of Progress of Commission of Foreign Forests, Victoria, 1871.—Report of the Entomological Society for Ontario for 1871.—The School Laboratory, vol. ii., No. 1.—The Sun and the Phenomena of the Atmosphere: Prof. C. A. Young.—Fourth Annual Report on the noxious and beneficial Insects of Missouri: C. V. Riley.

FOREIGN.—Atti della reale Accademia dei Lincei, 1871.—Forme delle Protuberanze regioni del magnesio e del ferro sulla superficie del Sole: P. Tacchini.—Memorie della Società degli spettroscopisti Italiana, No 4.—Bulletins de la Société d' Anthropologie, Aug. et Sept. 1871.—Indice degli autori e delle materie della gazetta chimica Italiana, vol. i.—Contribution à une histoire générale et Encyclopédique des Sciences: T. Wechinakof.—La Belgique hortico le, Mai et Juin.—Osservazione dell' Eclisse totale: Prof. L. Respighi.—Sull' ultima Eclisse del 12 Dec., 1871: L. Respighi.—The Quarterly German Magazine, No. 1, for 1872.

DIARY

THURSDAY, JUNE 27.

SOCIETY OF ANTIQUARIES, at 8.30.—Origin of the word Coach: A. Goldsmid.—On the Ruins of Torre Abbey. Miscellaneous Antiquities: Sir W. Tite.

FRIDAY, JUNE 28.

QUEKETT MICROSCOPICAL CLUB, at 8.

MONDAY, JULY 1.

ENTOMOLOGICAL SOCIETY, at 7.

TUESDAY, JULY 2.

SOCIETY OF BIBLICAL ARCHÆOLOGY, at 8.30.—On Israel in Egpyt: Dr. H. Haigh.—On the Mazzaroth of Job XXXVIII: Henry Fox Talbot, F.R.S.—On the Use of the Papyrus among the Accadians: Rev. A. H. Sayce.—On the Economic Botany of the Bible: James Collins.

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