THURSDAY, MARCH 16, 1876

UNIVERSITY REFORM

THE discussion in the House of Lords on the second reading of the Oxford University Bill cannot be said to have been satisfactory. Those who took part in the debate were, almost without exception, Oxford men with high honours; and they evidently represented the opinions of the majority of Oxford residents. It is, indeed, a singular circumstance that there should be among the peers so large a proportion of persons who have gained first-classes, and who have themselves held "idle fellowships;" a proportion greater than can be found in the House of Commons. But the experience contributed by them, however valuable, ought not to have monopolised the whole discussion of the matter in a legislative assembly. Such experience is of the nature of one-sided evidence, which should be heard and weighed before a decision is reached; but which cannot be permitted to substitute itself for a thorough discussion of a subject of national importance. This aspect of the debate is the more to be regretted, because it will tend to encourage the feeling, which seems to be already predominant at Oxford, that the limited vision of the present race of University residents, together with their own pecuniary interests, is to determine the course of academical reorganisation. The hopes raised by Lord Salisbury's first speech will be dashed to the ground, if such petty matters as the difference between the legislative functions of convocation and congregation, the influence of the parochial clergy on either body, or the period during which an "idle fellowship" should be tenable, are thrust forward as the supreme considerations. These subjects, no doubt, require to be discussed and settled, once and for all; and it is, perhaps, an omission that they have not found a place in the Government measure. But no misfortune would be graver than if it were to go to the country, as the Liberal peers seem to wish, that the Bill does not contain principles of reform, in comparison with which these details sink into their proper insignificance.

Lord Salisbury's speech was welcomed, certainly by men of science, and we believe also by all those whose ideal of a university is not confined to what they learned during their adult school-days at Oxford or Cambridge, because he unhesitatingly announced two new principles, upon which the whole merits of the scheme turn. He proposed that the University should be endowed at the expense of the colleges, and that scientific research should take its place in the University by the side of religion and learning. Now, these two main principles were entirely disregarded in the discussion of last Thursday; or, when they were referred to, were "damned with faint praise." The Archbishop of Canterbury, whose speech was, on the whole, worthy of his position, professed himself ignorant of the precise meaning to be attached to the word "research;" as if there had not been, during the last three years, abundance of discussion on the subject in the press, and as if it had not been defined in the report of a Royal Commission. Both Lord Carlingford and the Earl of Morley reproduce the old argument, which to those familiar with the topic has long ago been worn threadbare, that the endowment of teaching professors is the only endowment of research which is either desirable or possible. It is not necessary in these pages to show how entirely is this objection founded upon ignorance. It is enough to observe that those very persons who are the most ardent advocates of the present system of awarding fellowships as sinecures, express themselves as most fearful of the danger of opening these sinecures to the physical sciences, and imposing on their holders the duty of original investigation. Lord Morley was in his day a distinguished classical student at Balliol College; but, so far is he from understanding the new demands of the present time, that he concluded his speech with the following idle peroration:—"I trust that the University, reinforced by the proposed aids, will take up the proud position *she has so long held*, and will, I hope, long continue to hold, as *the head and centre of all science* and learning." With regard to the proposal to satisfy the admitted wants of the University out of the surplus income of the colleges, hardly a word was said. Everybody was too anxious to support the condemned system of "idle fellowships," to bestow a thought upon the profitable uses to which these misapplied funds might be devoted. And so the House of Lords read the Oxford University Bill a second time, without any deliberate consideration of its essential features, but evidently prepared to dispute in Committee over all sorts of uninteresting details.

There is, however, one important point, on which not only the House of Lords, but also the nation at large, seems in danger of being misled. This has reference to the intentions of founders, and the original object for which fellowships were endowed. It seems to be universally assumed that the intention of the founders was primarily to promote religion, and secondarily education. "Orignally," said the Earl of Carnarvon, "religion was the object of the University; then, after a struggle, learning was added;" and now it is proposed to complement the two former by the addition of research. Against the theory implied in the last clause nothing can be urged; but the two former statements represent a most perverted view of history. The Archbishop of Canterbury, who ought to be better informed, is equally wrong, though less positive. "We know very little, perhaps, now of the exact intentions of the founders. We do know that many of them were desirous to benefit their own souls by having masses celebrated in their own Colleges; . . . but when that is said, we know very little more than that they had a general desire to promote education." Now, as a matter of fact, there is no historical evidence whatever, to show that the University or the colleges commenced with religious observances, and that learning had a hard fight to enter in. So far as we know anything about the condition of the University of Oxford in the pre-collegiate epoch (and it is true that our knowledge of that period is very small), it is certain that the University of Oxford, like the sister University of Paris, was an assembly of teachers and students, by no means of priests and monks. Study was the primary object then, as later, to which religious functions were only subordinate. No doubt the majority of the learned men were *clerici*, *i.e.*, in orders, but so were the lawyers at that time, and the Universities are no more ecclesiastical corporations than

are the Inns of Court. From the date of the foundation of the first college our knowledge becomes more definite. The original statutes have been preserved, and were published to the world by the University Commissioners about twenty years ago. The evidence, therefore, of the intentions of the early founders of fellowships is abundant, and it is also decisively clear. It was, no doubt, desired that the study of Theology should be supreme, and ample provision was made for divine worship; but it must be recollected that in those days Theology included Law, and did not exclude Natural Philosophy. But what the founders had foremost in view, as might easily be shown by copious extracts from their statutes, was not religion, or even education, but advanced study. The few earliest colleges make no reference at all to the endowment of teaching. Their fellowships were established "for the support of indigent scholars in the University of Oxford, who are bound to study and make progress in the divers Sciences and Faculties." The function of teaching was left to be performed by the University, and all those who had taken the higher degrees enjoyed the privilege, as they were under the obligation, of giving instruction. "To study, not to teach, was the business of the Fellows. The founder of Queen's College has even expressly stated that he intends his benefaction to relieve his Fellows from the necessity of teaching." The full period of study required for the degree of Doctor lasted for thirteen or nineteen years, varying in the different faculties; and the fellowships were intended to support poor students during this long season of probation. Nor must it be supposed that Theology and the Classics were the only subjects meant to be encouraged. Many of the founders made provision for the study of medicine; at New College Astronomy is specially mentioned; and William of Waynflete, in the statutes of Magdalen, expressly prescribes Natural Philosophy as one of the three departments of knowledge which the Fellows were to cultivate. Other instances of a similar nature might be quoted; but nothing further is required to prove what the colleges themselves will scarcely admit, that the fellowships were given not as prizes to stimulate clever boys, nor as subsidies for academical teachers, but to promote mature study. The appeal, therefore, to the intentions of the founder does not lie in the mouth of the advocates of the existing order of things, but is one of the strongest arguments that can be used by those who support the endowment of research, which turns out to be merely the restoration of the old practice.

MINERALS OF NEW SOUTH WALES

Mines and Mineral Statistics of New South Wales. Compiled under the direction of the Hon. John Lucas, M.P.; also "Remarks on the Sedimentary Formations of New South Wales." By the Rev. W. B. Clarke, M.A., F.G.S. (Sydney, 1875.)

THE volume now before us is a companion to that we reviewed recently in this journal on the minerals and rocks of Victoria,* and like it has been called forth by the necessity of cataloguing and describing the collection of specimens exhibited at the Metropolitan Intercolonial Exhibition held at Sydney in 1875, which consisted of rock-specimens, fossils, samples of coal, ores of iron, and other metals, collected by the Examiner of Coal-fields, the Government Geologists, and furnished to a large extent by the owners of mines, the whole being arranged by Mr. C. S. Wilkinson, Government Geologist to the colony. The volume also contains statistics of the minerals raised in 1874 and preceding years. These do not pretend to be more than approximations, but they are sufficient to enable us to see the strides this great colony is making in the development of those mineral treasures which are almost lavishly bestowed throughout the area already explored, and which give promise of still wider distribution; meanwhile, the authorities seem fully alive to the importance of having accurate returns. It is stated that "the arrangements for the future are such as it is hoped will secure the collection, publication, and preservation of complete and authentic returns, and no pains will be spared to render our records of the past more complete than they are at present."

It may interest our readers, however, to be put in possession of the latest returns, which are for the year 1874, and are as follows:—

	Total Value.
Gold	£30,656,246
Coal	6,565,328
Tin	866,461
Copper	807,476
Oil-shale (Kerosine)	261,414
Silver	77,216
Iron	15,434
Antimony	897
Total	£39,220,472

It is impossible to rise from a perusal of this volume without the conviction that the resources in not only the precious metals, but the more useful minerals—coal and iron—are practically inexhaustible, and that being developed by British colonists are destined, or are at least calculated, to produce a nation rivalling the mother-country in manufacturing industry. We gather that the colonists now fully perceive this themselves; and for this they are to no small degree indebted to the voluntary labours of that veteran geologist, the Rev. W. B. Clarke, who for a quarter of a century has been engaged in exploring the interior of the continent and unfolding its geological structure. A more detailed survey is now in progress, which has been attended with highly encouraging results; and it would be well for intending settlers to possess themselves of all the available information afforded by the maps and reports of the geological surveyors, as by this means they may become the happy possessors of treasures lying below the surface. Meanwhile, sufficient is known to enable us to give a short sketch of the physical features and geological structure of this great colony.

New South Wales is bounded on the south by the Murray River—separating it from Victoria—and on the north by a line generally corresponding to the 29th parallel, by which it is separated from Queensland.

The coast line extends from Cape Howe to Point Danger, a distance of nearly 700 miles, with the Ports of Wollongong, Sydney, Newcastle, and the Clarence River at intervals. At a distance from the coast-line, varying

* "Rocks and Minerals in the Melbourne Museum," NATURE, vol. xiii. p. 165.

from 30 to 150 miles, runs the Cordilleras range of mountains—sometimes serrated, at others tabulated—and reaching elevations of 6,000 or 7,000 feet. "The highest point in all Australia," is at the head of the Murray River and near the boundary with Victoria, being, according to Strzelecki, 6,500 feet above the sea, but according to the later observations of Clarke 7,175 feet. From the base of this range the country extends in a spacious plain to the sea margin, and on the west into the great central wilds of South Australia, and the regions watered by the Darling, the Lachlan, and the Murrumbidgee Rivers. The central tract from the coast to the Cordilleras is occupied by the Sydney coal-field, having a sea-board of about 200 miles, and an area of over 15,400 square miles—as estimated by Mr. J. Mackenzie, F.G.S., Examiner of the Coal-fields—richly stored with coal, and, along its western margin, with iron. Newcastle in Australia is a coal-shipping port, as well as the Newcastle in the old country, and from the number of projected lines of railway communicating with it, it is clear that the neighbouring collieries are destined to distribute mineral fuel into the far interior, as well as to the ocean steamers and coast towns.

Another point of similarity between the mother-country and her daughter, dates from the far-off ages of Geologic time; for Mr. Clarke and other geologists have clearly demonstrated that the coal-beds of New South Wales and of Britain were elaborated in Nature's workshop during the same Geological period; and on comparison it will be found that the general succession of the members of the Carboniferous series in the North of England and Scotland have their equivalents, as nearly as possible, at the Antipodes. This may be accidental, but it is at any rate a striking illustration of the prevalence of similar conditions over wide areas of the globe during the Carboniferous period.

The general succession of the Upper Palæozoic series of New South Wales and their possible British representatives is as follows:—

	New South Wales.	Great Britain.
(*e*)	*Wianamatta Series.*—Shales, with fish (*Palæoniscus*), fresh-water shells, and plants. 500 feet.	(*e*) Possibly Permian Beds.
(*d*)	*Hawkesbury Series.*—Chiefly sandstones, with ferns (*Glossopteris browniana*). 1,000 feet.	(*d*) Upper Red Sandstone of the Glasgow district.
(*c*)	Upper Coal-measures of Newcastle, &c., with plants—as *Glossopteris*, *Sphenopteris*, Conifers—with sixteen coal-seams over three feet in thickness. 480 feet.	(*c*) Upper coal-measures of Scotland, with Millstone Series at base.
(*b*)	*Upper Marine Beds.*—Shales, sandstones with coal-seams, &c., with numerous Lower Carboniferous shells (*Spiriferæ*, *Producti*, Crinoidal stems. 350 feet. *Lower Coal-measures.*—Shales, sandstones with similar fossils. 100 feet.	(*b*) Lower coal-measures of Scotland of the Carboniferous Limestone age.
(*a*)	*Lepidodendron Beds.*—Shales and sandstones, with Carboniferous plants (*Cycloptoris*, *Knorria*, *Sigillaria*, *Lepidodendron*) resting unconformably in Devonian beds.	(*a*) Calciferous Grit Series.

Though Prof. M'Coy considers, on palæontological grounds, that the upper beds of the above series may be of Mesozoic age, we are unable to concur in that view, and consider Mr. Clarke's demonstration of their Palæozoic age conclusive. The whole series, with the exception of the Wianamatta shales, are conformable throughout, and the differences in the flora and fauna between the Upper and Lower series are not greater than those between the Upper and Lower Carboniferous beds of Great Britain.

The quantity of coal raised in 1874 amounted to 1,304,567 tons, and the returns of the out-put since 1829 show a steady annual increase. The demand in the future is likely to exceed the supply; but collieries are being rapidly opened up where means of transport to the markets are available.

Amongst the most valuable products of the coal-fields are the "Kerosine shales," a kind of oil-shale or cannel, of which 96,141 tons were raised in 1874 from three mines. These beds resemble the oil-cannel of Torbane Hill in Scotland, and the associated shales from which the celebrated paraffin oil is extracted. Some of these seams are exceedingly rich, and are used for the production both of petroleum and gas. Beds of clay-ironstone, besides large veins and masses of brown hæmatite, occur towards the base of the Carboniferous rocks in several places, amongst which those of Wallerawang are likely to become of the highest importance. A detailed account of the various ores has been drawn up by Prof. Liversidge, accompanied by chemical analyses, which show that the ores are rich, containing from 40 to 56 per cent. of metallic iron. Other iron-producing works have been established at Lithgow Valley and Berrinia, but space forbids fuller reference. For the accounts of the gold, silver, and precious stones, including the diamonds of Inverell and Armidale, we must refer to the pages of the book itself, which, though full from cover to cover of valuable information, suffers much from the want of a good index.

OUR BOOK SHELF

Geological Sketches. By L. Agassiz. Second Series. 8vo. pp. 229. (Boston, James R. Osgood and Co.; London, Trübner. 1876.)

No better idea can be given of this little book than is obtained from the first few words of the preface. "This edition of the 'Geological Sketches' offers nothing new to the public. Taken in connection with the former one, it only presents in a permanent form and in their original sequence all the geological and glacial papers contributed by Prof. Agassiz to the *Atlantic Monthly* during a number of years." It consists, in fact, of five chatty papers on glacial phenomena in various parts of the world, written in that kind of personal manner that makes them read like a book of travels or a chapter of an autobiography. It is perhaps chiefly from this latter point of view that this collection is interesting. Whatever may be Agassiz's position with respect to the interpretation of the phenomena of recent glaciers, there can be no question but that to him is due the first recognition of their former existence and extent in this country and elsewhere where they now no longer exist. From the day of that discovery in 1840, "Glacial Geology," now a department by itself, has been steadily growing, till investigations into the work of ice has been carried into almost every part of the globe, not excluding the Tropics. Agassiz has therefore a fair right to the title of Father of Glacial Geology. He gives us here an interesting sketch of his first opening up this ground by his visit to Scotland, and puts in a popular

form his theory of the formation of the parallel roads of Glen Roy. We have a glimpse of his well-known tone of thought in the question which he says, in one of these essays, one *naturally* asks, "What was the use of this great engine set at work ages ago to grind, furrow, and knead over, as it were, the surface of the earth?" and finds as an answer that it was a special provision for making the surface fertile by ploughing it deeply and preparing it as a grain-growing soil. Perhaps we could not have a better justification for calling teleological arguments "barren virgins," with Prof. Huxley, than this instance, for if the glacial period were a special provision for the wants of man, we should be cut off from the conclusions, now almost proved by evidence, first that man existed in these isles *before* the glacial epoch, and second, that this epoch should rather be called the *last* glacial epoch, as there have been similar ones throughout geologic time. This last conclusion, involving the extension of glacial conditions through a long range of time, at various intervals, a conclusion largely due to Prof. Ramsay, will be only second in importance, when fully established to its extension in space so conclusively proved by Agassiz and others. The longest of the five papers in this collection is the most recent: "On the Physical History of the Valley of the Amazons," in which he gives his reasons for considering the whole of that valley to have been filled with ice, and to have extended much further to the east at that period. This is scarcely the place for discussing conclusions that have been made known in a larger work with the evidence stated; but we may call attention to the fact that no furrows, striæ, or polished surfaces are anywhere to be found there, and the evidence, therefore, is not of that positive character that so remarkable a conclusion would seem to demand. The country is so little known that at any time fresh observations might modify any conclusion drawn from negative or secondary evidence.

To the Victoria Falls of the Zambesi. Translated from the Original German of Edw. Mohr. By N. D'Anvers. (London: Sampson Low and Co., 1876.)

IN noticing the German edition of this work (NATURE, vol. xii. p. 231) we said that it was well worth translating into English, and we are therefore glad to see that Messrs. Low and Co. have put it within reach of the English reading public. The work is full of interest, and is a really valuable contribution to our knowledge of the region traversed—from D'Urban to the Victoria Falls of the Zambesi. Mr. D'Anvers has done his work of translating very satisfactorily, judiciously omitting a few passages which deal with matter already brought before English readers. All the original illustrations seem to have been retained, including the brilliant but tasteful chromo-lithographs. A new route-map, on a larger scale than the one in the German edition, has been constructed for this translation.

Sport in Abyssinia, on the Mareb and Tackazzee. By the Earl of Mayo. (London: John Murray, 1876.)

THE Earl of Mayo seems to have published this book to show intending sportsmen in Abyssinia how not to do it. His expedition, organised solely for sport, was rather an unfortunate one. Very little sport was obtained by the author, and ere he had well set to work, he was taken so ill that he had suddenly to return to Massowah to catch a homeward-bound steamer. The work contains some shrewd observations on Abyssinian people and affairs, and will no doubt be appreciated by sportsmen.

Health in the House. By Catherine M. Buckton, Member of the Leeds School Board. Sixth edition. (London: Longmans and Co.)

THIS useful book consists of twenty-five lectures on Elementary Physiology in its application to the daily wants of Man and Animals, delivered to the wives and children of working-men in Leeds and Saltaire. It will be found a great help to national schoolmasters and others engaged in education, who may desire to give their pupils clear ideas of the structure and life of man, together with a practical knowledge of the necessity of fresh air and cleanliness in their daily life. At the end of the book will be found questions on some of the lectures, a list of works useful for preparing lectures, and tables of foods most suitable for health.

LETTERS TO THE EDITOR

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

Corrections in the Address of the President of the Royal Microscopical Society (Vol. xiii. p. 332)

BY some unaccountable oversight in copying out the data for calculating the number of molecules of liquid water, the factor expressing the specific gravity of the vapour of water was omitted, and afterwards overlooked. The number of atoms of a gas should really be multiplied by $\frac{8}{9} \times 770 \times \frac{1}{\cdot 6239} \times \frac{1}{3} = 617$. But moreover, on reflecting on the relative reliability of the determinations by the various authors of the number of the atoms in gases, it appears that in taking the mean, greater weight ought to be allowed to that by Clerk-Maxwell, since founded on more recent and accurate data. If his results be considered as of equal value to those of Storey and Thomson combined, the mean would be reduced to so nearly the same extent as the molecules of liquid water would be increased by the above-named correction, that the numbers given in the address may be considered to be as good an approximation to the truth as can be determined in the present state of the question, and none of the general conclusions need be modified. H. C. SORBY

Vivisection

I HOPE that you will permit me to call attention to a passage in the "Statement of the Society for the Protection of Animals liable to Vivisection on the Report of the Royal Commission on Vivisection" (published by the Society, 1, Victoria Street, Westminster). Under the heading "Extracts of Evidence on Extension of the Practice of Vivisection, and Abuses connected therewith," the following words occur (p. 22):—

"Dr. Crichton Brown describes:

"Forty-six animals sacrificed in trying if chloral were antagonistic to pycrotoxine. Cases of poisoning by pycrotoxine are of very rare occurrence. Twenty-nine animals used in Ferrier's series."

I will leave your readers to judge of the kind of impression which this passage tends to give; I will only ask, is it in accordance with the ordinary principles of justice that the following important details (also gathered from Dr. Crichton Brown's evidence) should be entirely omitted by the compilers of the Statement?

1. "Pycrotoxine is sold in large quantities as Barber's poisoned wheat for the destruction of birds" (3218). Concealed in an edible substance, this poison must therefore pass largely through the hands of an ignorant and careless class of persons.

2. Dr. Crichton Brown "succeeded in proving that after a poisonous dose of pycrotoxine has been given to an animal, if a dose of chloral be given subsequently the animal will recover" (3163).

3. The operation to which the animals sacrificed were subjected "consisted in the introduction under the skin of a little fluid by means of a perforated needle . . . . the pain is infinitesimal" (3218).

4. The after effects are convulsions and death, and "convulsions themselves are not necessarily painful" (3218). This is proved by direct and distinct evidence.

5. In consequence of the use made of Barber's poisoned wheat, "numbers of animals die of it in convulsions every year" (3218). It is almost incredible that a course of action which may result in saving human life should be mentioned in the manner above quoted; while a course of action identical as far as the ultimate effect on the animals is concerned, in which

there is no question of saving life, and which is repeated a thousand times for the private benefit of its performers, is omitted!

6. In Dr. Ferrier's research, anæsthetics were so "carefully and liberally given," that five animals out of the twenty-nine sacrificed "died before they were touched or operated on in any way" (3178).

FRANCIS DARWIN

Down, Beckenham

The Use of the Words "Weight" and "Mass"

IN a letter with the above heading published in NATURE, vol. xiii. p. 325, Mr. Bottomley has recommended that the ambiguity of the word weight shall be avoided by using the phrase "the gravity of a pound" when we mean the downward force due to the earth's attraction upon a pound weight.

The ambiguity against which Mr. Bottomley wishes to guard is a very real one. Not to speak of common usage, which allows three meanings of the word weight to be loosely intermingled, we have two of these meanings adopted into scientific nomenclature. The universal practice in chemistry is to employ the word weight to signify mass, and anyone may satisfy himself that this use of the word could not be dispensed with in that science by making the attempt to substitute other forms of expression for the convenient words weight, heavy, light, heavier, lighter, as used by chemists. On the other hand, physicists have generally employed the term to signify a force, and the best writers on mechanics are careful to avoid using it to express mass.

But I fear Mr. Bottomley's remedy, if adopted, would introduce quite as serious, perhaps a more serious, ambiguity. Gravity is an acceleration. When we say that gravity is less in a balloon or in a mine than at the surface of the earth, or greater at Glasgow than at Manchester, we are speaking of alterations of g—the acceleration due to the earth's attraction; and it would create confusion to employ this word to designate forces also.

But a practice which I adopted in lecturing on mechanics in Queen's College, Galway, many years ago seems to meet the difficulty, and may perhaps recommend itself to other teachers. It is to use the word *gravitation* in the proposed sense.

If this were done, *gravity* at Glasgow would mean an acceleration; the *gravitation* of a kilogramme there would be a force; and *weight* would continue a word of doubtful import, to be judged of by the context, sometimes used for a force, sometimes for a mass, and sometimes for those pieces of metal which are employed as measures in weighing (as in the phrases "a set of weights," "a gramme weight"). In further support of my suggestion, it may be observed that the proposed use of the substantive *gravitation* follows legitimately in the English language from the established meaning of its correlative, the verb *gravitate*.

I would wish to take this opportunity of also recommending a prefix which I have found of the utmost service both to students by assisting them to acquire clear conceptions with ease, and to myself. We use the prefix *hyper* placed before the name of any metrical weight, as hyper decigramme, hyper-gramme, hyper-hektogramme. hyper-kilogramme, hyper-tonne, to indicate those forces of the absolute metrical series which are slightly larger in amount (about 2 per cent. more) than the gravitation at the earth's surface of the decigramme, gramme, hektogramme, &c., respectively.

When a student has to use weights as forces, as he must in the laboratory, he should be trained from the beginning to think of them in their relation to the neighbouring absolute forces. For instance, if he uses a hektogramme to exert a pressure, he should be encouraged to think of it rather as $\frac{g}{10}$ ths of a hyper-hektogramme (which is a force) than as a hektogramme (which is more properly a mass). This will also keep prominently before his mind that the amount of the pressure depends on the station at which the experiment is made.

G. JOHNSTONE STONEY

Queen's University, Ireland, March 9

MR. BOTTOMLEY remarks in his letter on weight and mass that appeared in NATURE, vol. xiii. p. 325, that "During the present session we have aided ourselves in Glasgow with four very important helps to the teaching of the kinetic system of force-measurement. . . . The third help is the construction by Prof. Thomson, for the first time so far as I know, of spring balances for indicating poundals and kilodynes."

Will you permit me to point out that about three years ago Prof. Ball, when introducing the C. G. S. system of units into the course of mechanics at this college, had a series of dynamometers in absolute measure specially constructed by Messrs. Salter, of West Bromwich. These dynamometers were exhibited at the Bradford meeting of the British Association, and will also be seen at the forthcoming Loan Exhibition at the South Kensington.

W. F. BARRETT

Royal College of Science, Dublin

Metachromism

MR. FLINDERS PETRIE in his interesting letter (vol. xiii. p. 348) criticises the abstract of my paper which appeared in NATURE some weeks ago. Before considering his communication, I would remark that my argument against Schönbein's theory accounting for metachromism is based upon the colour relation which he mentions. I gave a small table of anhydrous binary compounds which conform to the rule, and that table includes the chlorides of chromium which Mr. Petrie has pushed out into the cold. The relation is thus referred to:—"Those compounds in a series which show the highest amount of the basylous element have the most refrangible colours." So far as I am aware, it is there announced for the first time.

For the sake of clearness we will first examine Mr. Petrie's proposition:—"Increase of the electro-negative element produces a colour-change towards the red end of the spectrum, and *vice versâ*."

Increase of the electro-negative element is *accompanied* by less refrangible colours, but to say that this increase *produces* the change is going farther than the observations warrant, is, in short, opposed to fact. For example, if we take the series of oxides of chromium which he gives—Cr_2O_3 green, CrO_2 yellow green, CrO_3 red, I fail to see that increase of the electro-negative element, *i.e.*, *colourless* oxygen *produces* a change towards the red end, or, on the contrary, that decrease in the positive element does the same. The facts seem rather to show that colour in any body is dependent upon the proximity of its molecules, since we find bodies which, with like chemical composition but different densities, have different hues.

The metachromatic scale given on page 298 is not intended to be absolute, and may, in fact, need a little modification with the accession of more knowledge. But certainly Mr. Petrie's remarks do not affect it, because (1), the colour gradation he refers to is attended by chemical differences, whereas in metachromatic phenomena we have purely physical alterations; (2) white does not come between yellow and blue, either in the "natural" or in the metachromatic arrangement. For if by "natural arrangement" he means that of the pure spectrum, then green is what intervenes between blue and yellow, and white has its nearest counterpart in the ultra-violet grey. Quite recently this part of the spectrum has been termed "silvery grey" by M. Sauer. Independently of this, however, I was led to place white in the ultra-violet part of the metachromatic scale by certain mineralogical facts which I shall not trouble your readers with detailing here.

The assertion, then, that white comes between yellow and blue, would seem to rest upon the colour relation found to obtain between the oxides of the alkali metals, which really is not worth much, because of the little we know about the sub-oxides; and because even the chief series he gives, that of sodium, is an exception to the rule, Na_2O_2 being pure white (Watt's "Dictionary," vol. v., p. 340), and not orange, as Mr. Petrie states; and, finally, because we cannot fairly compare the order of colour we see in the binary compounds with what we get in metachromatic phenomena, although to a great extent there is a colour parallelism which is remarkable.

WM. ACKROYD

Royal College of Chemistry, South Kensington,
March 4

The U.S. Survey Publications

IN NATURE, vol. xiii. p. 314, I observed a note upon the rumour that the publication of Prof. Hayden's Geological Reports was likely to be stopped by the U.S. Government.

Having brought the paragraph under the notice of the Museum Committee of the Town Council, I am requested by them to communicate with you, and to say that several of these Reports have been received by the Leicester Museum, and are regarded as of great value; and that the Museum Committee will be glad

to co-operate in any proceeding which may be thought most likely to induce the Government of the United States to continue the publication of them. FREDK. T. MOTT

Town Museum, Leicester, March 7

Origin of the Screw Propeller

I SHOULD like to remark, in reference to last week's letter on the origin of the screw propeller, that I have long considered the pectoral fins, which are so extremely useful to and prominent upon soles, or the family *Pleuronectidæ*, as being highly suggestive of this more modern mode of propulsion. Anyone who likes to watch these extremely interesting fish in their swimming movements and graceful gyrations may witness the action and I think attribute to its movements more than is possible in the case of ash and other seed vessels.

Valentines WILLIAM EARLEY

The Three Kingdoms of Nature

IN reply to your correspondent's question as to which of the three kingdoms "water" belongs, I beg to state that the strict scientific definition of a mineral, adopted in most mineralogies, is as follows: a mineral is any *inorganic*, *homogeneous*, *natural* substance.

This definition obviously includes water, which is accordingly always described in books on mineralogy; and the fact of water being a liquid at ordinary temperatures cannot of course exclude it from the list of minerals. Indeed, in some mineralogies, gases—such as carbonic acid, sulphurous acid, and even the air—are described as minerals. Water, like many other minerals, can exist in more than one form; thus, if the temperature of our globe were much lower than it is, we should only have water in the form of the transparent crystalline solid, known as ice, which—like other minerals, such as sulphur, metallic lead, metallic mercury, &c.—has its own particular point of fusion; thus: sulphur melts at 226° F., water at 32°, mercury at 39°. All these substances still further resemble one another in their capability of being converted into a gaseous form, at certain fixed temperatures. These facts—with many others—prove water to be as much a mineral as calcite or gypsum. E. G. C.

Upper Holloway, N., March 13

The Recent Storm

YESTERDAY'S storm appears to have been a true cyclone, and to have passed nearly centrally over here about half-past one o'clock. I first noticed the barometer at 11 A.M. I forward observations:—

Sunday.			Barometer.	
10	A.M.	Wind and rain S. ...	—	
11	,,	Strong ditto	27	
12	,,	Ditto from S.W. ...	26·9	
12.30	P.M.	Increased ditto... ...	26·85	
1	,,	Great gale, S.W. ...	26·8	falling still.[1]
1.20	,,	Ditto, S.W.	At	
1.35	,,	Calm	lunch.	
2	,,	Strong wind from N. with driving sleet....	26·8	rising.
2.30	,,	Gale, snow and sleet..	26·85	
3	,,	Ditto, rather increased	26·9	
4	,,	Brisk breeze, N. ...	27	
5	,,	Slight breeze, N. ...	27·35	
11	,,	... ...	27·9	

Being a rise $1\frac{1}{10}$ inch in seven hours.

Staplehurst, Kent, March 13 T. S. USBORNE

Bed-time

CAN any of your readers inform me on what ground the following saying is based, and to what extent it is true:—"One hour's sleep before twelve is worth two after."

March 10 VITA BREVIS

OUR ASTRONOMICAL COLUMN

COMET 1840 (II.).—In *Astronomische Nachrichten*, No. 2,079, Dr. Kowalczyk, of Warsaw, publishes his investigation of a definitive orbit for the comet discovered at Berlin, by Prof. Galle, the present Director of the Observatory at Breslau, on the 25th of January, 1840. This comet, which was last observed at Kremsmunster on the 1st of April, had already been made the subject of extensive calculation by Professors Plantamour and Loomis. The former, in 1843, discussing his own series of careful observations taken at Geneva, found (*Astron. Nach.*, No. 476) that a parabolic orbit represented the comet's course within the probable limits of error of observation; on including the series taken at Berlin he found the most probable orbit to be an ellipse, but of great excentricity to which little weight was considered to attach. Loomis, on his side, taking into account the effect of planetary perturbation during the interval of the comet's visibility, also found an ellipse, but with a more moderate excentricity, the period of revolution being about 2,420 years; the sum of the squares of the errors in the ellipse is diminished to one-third of the amount with the best determinable parabola. Loomis's investigation will be found in the "Transactions of the American Academy," vol. viii.; his orbits are not included in the extensive collection in Dr. Carl's "Repertorium der Cometen-Astronomie," a work which, notwithstanding its great utility to the student of this branch of the science, is yet not complete or free from numerical errors.

Kowalczyk starts with the parabolic elements obtained by Plantamour in 1843, comparing them with the whole course of observations. After introducing the corrections for aberration and parallax, and the earth's positions from Leverrier's tables, instead of those from the Tables of Carlini used by previous computers and by the usual method of equations of condition for ten normal places, he finally arrives at an elliptical orbit, very closely agreeing with observation, and showing a period of revolution of 3,789 years.

BERLINER ASTRONOMISCHES JAHRBUCH, 1878.—The Berlin Ephemeris for 1878 has been received during the past week. In its speciality—the ephemerides of the minor planets—Prof. Tietjen has evidently made a very vigorous and successful effort to keep pace with the frequent additions to the list; his volume contains approximate places for every twentieth day during the *present* year of 144 of the 160 small planets hitherto detected, and accurate opposition ephemerides of 71, occupying together one-third of the entire work. The collective table of elements to No. 147 inclusive is not the least important part of this volume of the *Jahrbuch*.

Prof. Tietjen continues to transfer to the Berlin work—of course after reduction to that meridian—the places of the moon from our *Nautical Almanac*, which, by order of the Admiralty, is invariably published three complete years in advance of that to which it applies, and considerably earlier than any other of the national ephemerides. The economy of labour of computation thereby effected, which is probably found by the conductor of the *Berliner Jahrbuch* of material assistance for the production of his extensive work on the minor planets, might possibly be extended in other directions. An ephemeris of the moon from Hansen's Tables, employed for all the European ephemerides, admits of pretty complete check at a small expense of calculation, and there appears to be no advantage derivable from an independent work involving such heavy labour as the computation of the moon's positions through a whole year. Prof. Tietjen contents himself with a few direct calculations from the Tables which he says "invariably exhibit a satisfactory agreement" with the results in the *Nautical Almanac*.

PHYSICAL SCIENCE IN SCHOOLS

WHEN I claimed for science a position of educational equality "both as regards *range and time* with classics and mathematics," I intended to express the *amount* of science teaching in the school curriculum which alone can satisfy the upholders of a scientific education. I am as fully aware as Mr. Wilson is of the

[1] N.B.—This is $\frac{1}{10}$ lower than I ever saw it before.

importance of a firm mathematical foundation, and I am as far from wishing to overwhelm the younger boys with science before they have mastered the elements of arithmetic and grammar and languages as he can be. My experience amongst boys has, however, not been such as to enable me to say exactly when a thorough science teaching ought to begin.

The mistake, as it seems to me, which is prevalent respecting science teaching in schools, is the notion that it is a subject to be *lectured* upon for two hours per week to those already educated, and who show an aptitude for it, whilst it can, and ought to, be introduced at a definite period as a regular part of *school work*. It is now usually made an extra subject, a quasi-amusement, put on the same footing as drilling or drawing, whilst it can, and ought to, be made as much a discipline as the Latin grammar or Euclid, affording, as it does, in my opinion, if properly taught, an excellent training ground for acquiring that reasoning power and habit of application which it is usually supposed can only be gained through one or other of these older channels. I am sorry that Mr. Wilson thinks that any man of science is misleading public opinion on this subject. This is a serious charge, but as it rests on a misconception, I remain convinced that in the long run public opinion will endorse our views.

It is out of my power to tell Mr. Wilson whose business it is to make the change to a better state of things, which he himself feels to be necessary, for he admits that the new examination is adverse to scientific education. I do, however, feel strongly that unless the authorities of our great schools and the examining Boards set earnestly to work to introduce this new discipline and give it (as many of them to their honour are now beginning to do) a fair field and no favour, the beneficial influence which these schools have had on English education, must soon begin to diminish.

The Balliol scholarships and the other great University "advertisements" I believe to be in many ways stumbling-blocks in the path of true education in this country; "the many," as Mr. Wilson truly says, "are kept to swell the triumph of the few," and the prizes have to be got "at any cost to boy or school." Are we never to break loose from this degrading bondage to the Moloch of examination? I for one think better both of commissioners, governors, and head-masters, and look forward with hope to the ultimate emancipation of school-boys from their ancient fetters. Then those subjects will be taught at school which are best suited to make the mass of boys good citizens, and to forward the highest interests of the country, instead of the great aim of the schoolmaster being to secure a Balliol scholarship. We shall then see less than we do now of University men taking to sheep-farming in Australia, and hear less complaint of the superiority of our continental friends both in pure science and its application.

HENRY E. ROSCOE

PROF. FLOWER'S HUNTERIAN LECTURES ON THE RELATION OF EXTINCT TO EXISTING MAMMALIA [1]

IV.

IT was mentioned in the last lecture that no true Proboscideans have been found below the Miocene strata, but among the most remarkable of the numerous recent discoveries in the Eocene formations of Wyoming Territory, North America, has been that of a group of animals of huge size, approaching, if not equalling, that of the largest existing elephants, presenting a combination of characters quite unlike those known among either recent or extinct creatures, and of which there were evidently several species living contemporaneously. To form some idea of their appearance, we must imagine animals very elephantine in their general proportions, elevated on massive pillar-like limbs, with the same complete radius and ulna, the same short, round, five-toed feet which distinguish the elephants from all other known hoofed quadrupeds. The tail, as in the elephants, was long and slender, but the neck, though still short was not so much abbreviated as in modern Proboscideans, and there is no good evidence of their having possessed a trunk. The brain was exceedingly small for the size of the creature. The head differed greatly from that of the elephants, being long and narrow, more like that of a rhinoceros, and, as in that animal, was elevated behind into a great occipital crest, but unlike that or any other known mammal, it had developed from its upper surface, three pairs of conspicuous laterally diverging protuberances, one pair from the parietal region, one over or in front of the orbits, and one near the forepart of the elongated nasal bones. Whether these were merely covered by bosses of callous skin, as the rounded form and ruggedness of their extremities would indicate, or whether they formed the bases of attachments for horns of still greater extent, either like those of the rhinoceros or the cavicorn ruminants, must still be a matter of conjecture. But in either case they must have given a very strange aspect to the creature which possessed them, and have been formidable weapons in encounters either with animals of its own kind, or with the fierce carnivorous beasts whose remains are associated in the same deposits with them. There were no incisor teeth in the upper jaw, but a pair of huge descending canine tusks very similar in position and form to those of the musk-deer. Behind these, and at some distance from them, were, on each side above and below, six molar teeth of comparatively small size, placed in continuous series, each with a pair of oblique ridges, conjoined internally, and diverging externally in a V-like manner, and with a stout basal cingulum. The lower incisors and canines were small, and are only known at present by their sockets. The dental formula is—

$$i\,\frac{0}{3}\;c\,\frac{1}{1}\;p\,\frac{3}{3}\;m\,\frac{3}{3} = 34.$$

The first discovered evidences of the existence of animals of this group were described by Leidy in 1872, under the name of *Uintatherium*, from the Uintah Mountains, at the base of which they were found. Very shortly afterwards other portions of bones and teeth of either the same or closely allied forms, were described by Marsh as *Dinoceras*, and by Cope as *Loxolophodon* and *Eobasileus*. Whether these names will ultimately be retained for separate generic modifications, or whether they will have to be merged into the first, it would be premature to attempt to decide upon the evidence before us. A more important question is, what are the affinities of the animals, and what light do they throw on the general evolutionary history of the class to which they belong? Looking at the totality of their organisation as already known, at first sight they seem to present a considerable resemblance with the Proboscidea. The absence of the third trochanter, and of the fossa for the ligamentum teres on the femur, and the general form of the feet with their short broad toes are quite Proboscidean characters, but a closer examination of the structure of the carpus and tarsus, especially of the mode of union of the different bones with each other, shows more essential affinities with Rhinoceros. The same may be said of the cranium, so that on the whole they appear to come nearer to the Perissodactyle Ungulates than was formerly supposed. This relationship is strengthened by the discovery of other forms, constituting the genera *Bathmodon* and *Metalophodon* of Cope, of earlier geological age, which with the same general structure of the *Uintatheriidæ* retain in a most interesting manner many primitive characters, especially the complete number of incisor and premolar

[1] Abstract of a course of lectures delivered at the Royal College of Surgeons "On the Relation of Extinct to Existing Mammalia, with Special Reference to the Derivative Hypothesis," in conclusion of the course of 1873. (See Reports in NATURE for that year.) Continued from p. 356.

teeth. These are forms for fuller information upon which we anxiously wait.

The negative evidence (which of course must be received with the greatest caution in palæontology) of the absence of remains of any of these animals in the true Miocene or Pliocene deposits of North America, indicates that the race became extinct at least in that land, though it possibly may have emigrated elsewhere, and perhaps in Asia, may have laid the foundation of that family which first appears in the Old World under the more familiar aspect of typical Proboscideans. While, however, there are no grounds for assuming that the latter were derived directly from the Eocene Bathmodons and Uintatheriums, it is not too much to look upon these as affording some indications of the steps by which the process might have taken place, and, as such, their discovery is one of the most interesting that has been revealed by modern palæontological research.

It should be mentioned that Marsh, who has given us very full information upon the osteology and dentition of this group, has made of *Uintatherium* and its immediate allies a peculiar order of mammals, to which he gives the name of *Dinocerata*, while Cope, who formerly included them in the Proboscidea, and placed *Bathmodon* and its allies in the Perissodactyla, has recently formed an order called *Amblypoda*, containing two sub-orders, of which *Dinocerata* is one, and *Pantodonta* (*Bathmodon* and *Metalophodon*) the other.

The tertiaries of South America have yielded some very remarkable forms of mammalian life, the nature and affinities of which have greatly puzzled all zoologists who have attempted to unravel them. *Macrauchenia* has been already described among the Perissodactyle Ungulates, of which group it is undoubtedly a member, although in some characters somewhat aberrant. The articulation of the fibula with the calcaneum is an Artiodactyle, or perhaps generalised character. The teeth ally it to Palæotherium and Rhinoceros. *Homalodontotherium* from the banks of the River Gallegos, South-east Patagonia, is known by the teeth alone, which, though very generalised, are on the whole rhinocerotic. *Nesodon*, from the same locality, also only known by the dentition and some parts of the skull, connects the last and *Macrauchenia* with *Toxodon*. These three genera have the typical dental formula of $i\,\frac{3}{3}\ c\,\frac{1}{1}\ p\,\frac{4}{4}\ m\,\frac{3}{3} = 44$. *Toxodon* is an animal about the size of a hippopotamus, of which many specimens have now been found in Pleistocene deposits near Buenos Ayres, which have been described by Owen, Gervais, and Burmeister. The teeth consist of incisors, very small lower canines, and strongly curved molars, all with persistent roots; the formula being apparently $i\,\frac{2}{3}\ c\,\frac{0}{1}\ p\,\frac{4}{3}\ m\,\frac{3}{3} = 38$. The cranial characters exhibited a combination of those found in both Perissodactyles and Artiodactyles, but the form of the hinder part of the palate, the absence of an alisphenoid canal, and especially the tympanic being firmly fixed in between the squamosal and the exoccipital, ankylosed to both, and forming the floor of a long, upward directed meatus auditorius, is so exactly like that of the *Suina*, that it is difficult to believe that it does not indicate some real affinity to that group. These characters seem to outweigh in importance those by which some zoologists have linked it to the Perissodactyla, and the absence of the third trochanter, and the articulation of the fibula with the calcaneum tell in the same direction. The structure of the feet is not known, but it is probable that it had five toes on each.

Mesotherium, Serres, also called *Typotherium* by Bravard and Gervais, was an animal rather larger than a Capybara, and of much the same general appearance. Its skeleton is completely known, and shows a singular combination of characters, resembling Toxodon, or a generalised Ungulate on the one hand, and the Rodents, especially the *Leporidæ* on the other. In the presence of clavicles, of five toes on the fore-foot and four on the hinder, it differs from all existing Ungulates, and yet if it is considered as a Rodent, it must be looked upon as a most aberrant form. The teeth are $i\,\frac{1}{2}\ c\,\frac{0}{0}\ p\,\frac{2}{1}\ m\,\frac{3}{3} = 24$. Although our knowledge of many of these forms is still very limited, we may trace among them a curious chain of affinities, which, if correctly interpreted, would seem to unite the Ungulates on the one hand, with the Rodents on the other; but further materials are needed before we can establish with certainty so important a relationship, one which, if true, would alter materially some of the prevailing views upon the classification of mammals. It may be convenient provisionally to include those Ungulates which are neither *Artiodactyla* nor *Perissodactyla*, under a third heading, of which *Polydactyla*[1] would be the appropriate designation; though there is no evidence that they form such a homogeneous group as either of the other two.

(*To be continued.*)

PROF. HUXLEY'S LECTURES ON THE EVIDENCE AS TO THE ORIGIN OF EXISTING VERTEBRATE ANIMALS[2]

I.

TWENTY years ago the arguments as to the causes of the phenomena of organic nature, brought forward in support of the then recently advanced views of Mr. Darwin, were largely speculative; all one could hope to show was that no valid objections could be urged against the theory of evolution. But since that time "many have run to and fro and knowledge has been increased"; the question has come out of the region of speculation into that of proof; every day increases our familiarity with the phenomena of life on the globe in antecedent ages, and so gives us the only valid evidence obtainable as to the evolution of living things.

When we consider any animal at the present day there are three hypotheses which may be put forward with regard to its origin: that it arose out of nothing, that it had its origin from dead inorganic matter, or that it arose as a modification of some pre-existing living being. It is hardly worth while to consider the two first of these hypotheses—for the first it would be utterly impossible to obtain any evidence, and the second is devoid of all ground of analogy, and opposed to all our knowledge of what actually takes place. The last, on the other hand, should, if true, be capable of some sort of proof—at any rate it can be brought to the test of facts.

It is quite conceivable that all evidence as to the origin of an animal may have disappeared, and that the problem becomes, in consequence, insoluble by direct evidence, analogy and probability being the only guides left. As a matter of fact, however, we possess in the 70,000 feet of stone, gravel, sand, &c., which form the earth's crust, fossil remains imbedded in chronological order, and in many cases so perfectly preserved, that all important details can be made out almost as well as in the recent state.

The plan adopted in these lectures will be not to give all obtainable evidence with regard to the origin of each group of vertebrate animals, but to select from each class one or two definite cases of living animals, and to see what evidences can be obtained, by going back in time, as to the way in which they have come about, or at any rate as to the extent of the duration of their existence.

[1] An extension of the order *Toxodontia* of Owen, and *Ungulata multidigitata* of Burmeister.

[2] A course of six lectures to working men, delivered in the theatre of the Royal School of Mines. Lecture I., Feb. 28.

To begin with fishes: we will take as our first example the very beautiful genus Beryx, a fish not unlike our sea-bream, found widely distributed through the deep seas, and extending to about 40° on each side of the equator. Like the perch or the sea-bream, it is a greatly *specialised* fish; the head is immensely large, the bony rays supporting the fins hard and unjointed, the ventral fins or representatives of the hind limbs situated just behind the head, under the throat, the operculum curiously ornamented, and the air-bladder completely shut off from the gullet; thus differing very markedly from a more *generalised* fish such as the herring or carp, in which the head is proportionally much smaller, the fin-rays soft and jointed, the ventral fins far back, the operculum not ornamented, and the air-bladder communicating by a duct with the œsophagus.

We now know that at depths greater than five or six hundred fathoms, the sea-bottom is to a great extent composed of a very fine greyish-white mud, sticky when first removed from the water, but afterwards hardening into a delicate friable stone, not at all unlike chalk. This mud, which is largely made up of shells of the minute marine organism *Globigerina*, forms the bed of thousands of square miles of sea in which Beryx lives, and there can be no doubt that when the fish dies it sinks to the bottom, and, its soft parts being destroyed, becomes gradually imbedded in the soft mud, there to remain until the present sea-bottom is upheaved and becomes dry land.

Now, as a matter of archæological evidence, what is known of the history of Beryx and of the source whence it proceeded? Naturally it is useless to seek for such evidence except in deposits formed under like conditions to those in which the fish lives at the present day. Through the whole of the Pliocene and Miocene epochs no deep-sea formations are known, but in the middle of the Eocene period—a time so remote that tropical plants flourished on the banks of the Thames, and crocodiles abounded in this country—we are acquainted with an extensive deep-sea deposit, the Nummulitic limestone, which, besides the fossil giving it its name, contains large quantities of Globigerina, in all essential respects like that of the present day. In this formation are found two forms closely allied to Beryx, but with such slight differences as to receive different generic names; these are known as Acanus and Pristigaster. On passing from the Eocene or lowest tertiary to the chalk or uppermost secondary formation, which bears the closest possible resemblance to the modern Atlantic mud—the two may, in fact, be looked upon as belonging to one continuous series of deposits—we find an actual Beryx, a fish differing no more from the modern Berices than the various modern species of Beryx do from one another. This fossil, owing to the fineness of the chalk-forming mud in which it was buried, is so perfectly preserved, that all the details of structure of its hard parts, even to the ornamentation of the scales, can be compared with those in the recent fish; and in this way the most conclusive evidence is obtained that the differences which separate it from its modern relatives are of no greater importance than those by which the recent species of Beryx are distinguished from one another.

Thus we have positive evidence that a fish altogether like the Beryx of the present day, existed millions of years ago, before the Alps, the Himalayas, or the Rocky Mountains were upheaved, and has continued to live ever since. In face of these facts we cannot but conclude that the modern Beryx is derived from that of the chalk, and that the hypotheses of its creation out of nothing, and of its origin from inorganic matter are, for scientific purposes, simply non-existant.

As to the form from which the Beryx of the chalk was derived, we have absolutely no evidence, for there is no trace of any such fish in any lower formation.

We now pass on to a fish of a far older and less specialised type than Beryx—the genus *Ceratodus*, recently discovered in Australia. This animal, which attains a length of six feet, is distinguished by the possession of very curious fins, consisting of a central lobe, with a surrounding fringe of fin-rays, and by the character of its teeth, which are produced into curious horn-like processes, so arranged that those of opposite jaws interlock. Ceratodus is probably a vegetable feeder, lives in fresh or brackish water, and is said sometimes to leave its native element and crawl about among the weeds on the bank. It is enabled to do this by the fact that it can breathe air directly as well as air dissolved in water; it has, in fact, besides gills, an organ which is altogether a half-way house between the air-bladder of a fish and the lung of an amphibian.

In the Wealden, the most recent estuarine deposit of which we have any knowledge, there is no trace of Ceratodus to be found, but this is hardly surprising, as only two or three small patches of the earth's surface formed at this epoch have been examined, and animals have a geographical distribution at all times. But on passing back to the Trias, a formation as far from the chalk in point of time as the chalk from the present day, we find teeth belonging to an undoubted Ceratodus, in shape and in microscopic structure, exactly like those of the modern Australian fish. No other remains of the Triassic Ceratodus have as yet been found, but teeth are known to be so important a diagnostic character that no naturalist would have any hesitation in naming the genus to which the fish bearing such teeth should be assigned.

Thus we have a far more astonishing example of a persistent type than was afforded by our Beryx, and as in the case of the latter fish, all trace of the actual genus Ceratodus is lost at this point, and we are obliged to content ourselves with a few singular hints as to the way in which the type has come about. The most valuable of these hints are obtained by a study of a singular group of fish found in great abundance in the Old Red Sandstone. These are distinguished by the possession of curious fringed fins, unlike those of any other fish except Lepidosiren and Ceratodus—in fact, one genus, Dipterus, has fins quite like those of Ceratodus, and its teeth and skeleton were formed on just the same type. It is doubtful whether there is any relation between Ceratodus and Dipterus in the way of ancestry, but the resemblance between them is remarkable.

It must seem rather strange for a known evolutionist to select as examples two fish like Beryx and Ceratodus, which, of all others, seem most likely to support the notion that species are immutable. The adverse side only of the question has been stated to-night, the other side will be treated of on future occasions.

THE OLD RED SANDSTONE

AT a meeting of the Glasgow Geological Society on the 24th ult., Sir William Thomson, F.R.S., president, in the chair, Prof. Geikie, F.R.S., communicated the results of recent researches into the "History of the Deposits known as the Old Red Sandstone." After a preliminary outline of our present knowledge on the subject, he proceeded to consider the development of the Old Red Sandstone in the British Isles under its accepted threefold division into Lower, Middle, and Upper. The Lower member, wherever its true base can be seen, is found to pass down conformably into the Upper Silurian rocks. But a well-marked line of demarcation, both by physical characters and fossil evidence, runs between the two systems. The Silurian formations continue replete with organic remains up to their uppermost zone; but on entering the red strata of the overlying system we meet with a remarkably abrupt change, for the fossils almost wholly disappear, and those which occur belong for the

most part to fishes and crustaceans. The author pointed out the geological evidence in favour of great terrestrial oscillations as explained by Prof. Ramsay, whereby the bed of the Silurian sea in our area came to be raised into land with wide lakes and inland seas. He showed that the beginnings of the movements which led to those results could be traced back a considerable way into the Silurian period, that over large tracts the Silurian deposits had been upraised before the close of that period, and that the oscillations continued during the accumulation of the Lower Old Red Sandstone, as indicated by the coarse conglomerates, the great mass of the deposits, and the unconformabilities traceable in them. Recent detailed work of the Geological Survey has brought to light the fact that this lower division of the Old Red Sandstone attains an almost incredible thickness. In Lanarkshire and Ayrshire Mr. B. N. Peach has found it to measure 15,000 feet. In Perthshire, from the combined surveys of Mr. Peach and Mr. R. L. Jack, it has been ascertained to reach a depth of more than 19,000 feet. But the author has found that traced eastward into Forfarshire and Kincardineshire, its thickness rises above 20,000 feet. And yet in no case is its top actually seen, since it has either been removed by denudation, or buried under some more recent unconformable formation. Nor is its base to be found, since along the flank of the Grampians a great fault runs from the North Sea at Stonehaven to the estuary of the Clyde, with the effect of throwing the strata of the Old Red Sandstone on end, sometimes for a distance of two miles from the line of the dislocation. The amount of displacement must be in some places not less than 5,000 feet, as indicated by the position of occasional outliers of conglomerate on the Highland side of the fault. One of the most striking features in the formation is the enormous development of its contemporaneous volcanic rocks. These are underlaid in Kincardineshire by about 5,000 feet of sandstones and shales, and they pass under the grey flags and conglomerates of Forfar, and an upper series of red and purple sandstones. They consist of thick sheets of various porphyries with beds of tuff and enormous masses of coarse volcanic conglomerates. Zones of grey flagstones, including the well-known beds of Carmylie near Arbroath, are intercalated in them. In the Ochil Hills, according to the measurements of Mr. B. N. Peach, this volcanic zone reaches a depth of not less than 6,500 feet. It runs from the sea-coast at Dunottar through the chain of the Sidlaw and Ochil Hills to near Stirling. It reappears south of the Forth, in the Pentland chain, and stretches south-westwards in great force across Lanarkshire and Ayrshire. The author then alluded to the fossils hitherto noticed in this part of the Old Red Sandstone in different parts of Britain, pointing out the contrast they present to those of the preceding Silurian rocks. He showed that in Forfarshire the well-known crustaceans and fishes had been obtained from strata, lying not as hitherto supposed at the base of the system, but several thousand feet higher, and that the fish-bed found by Mr. Mitchell in Kincardineshire, and supposed by Sir Roderick Murchison to indicate from its Acanthodian forms an approach to the middle Old Red Sandstone, really lay below the position of the Turin flagstones so well explored by Mr. Powrie.

The so-called "Middle" Old Red Sandstone is not known certainly to exist anywhere else in Britain than in the north of Scotland. This subdivision was introduced by Sir R. Murchison, and is based wholly on the evidence from fossils. It presents a remarkably distinct series of ichthyolites, which have not been met with in the Lower Old Red Sandstone of the south, and which have therefore been held to mark a higher series of deposits. The "Middle" Old Red Sandstone is typically developed in the well-known flags of Caithness. Those strata, long since described by Sedgwick and Murchison, cover nearly the whole of that county, and stretch into the Orkney and Shetland Islands. The author had measured a section of these on the east coast of Caithness more than 8,000 feet in thickness. They show conglomerates and red sandstones at the base, and similar strata reappear on different higher horizons. But on the whole, the series consists of dark-grey, hard, fine-grained flagstones, sometimes bituminous, often calcareous, and frequently abounding in remains of fishes, entomostraca, and land-plants. No evidence of contemporaneous volcanic action has yet been met with in these rocks. The general character of the whole series differs in many respects from that of the Old Red Sandstone on the south side of the Grampians, and appears to indicate widely different conditions of deposit. The basins in which the Caithness flags, and the Arbroath flags accumulated, were separated by the intervening mass of the Inverness-shire and Aberdeenshire highlands, as shown by the basement conglomerates on each side of the mountains. The author then dwelt on the fossil evidence and its bearings. He suggested that it could not be held to prove a "middle" series, and that it was not inconsistent with the idea that the Caithness flags really belonged to the Lower Old Red Sandstone, the peculiarities of their fauna not being greater than might be due to great differences of physical geography, and to the fact that the respective areas of deposit were isolated from each other. He further pointed out that some of the most characteristic forms of the lower group occur in the Caithness and Orkney beds, *e.g.*, *Pteraspis*, and *Pterygotus*. The Caithness flags abound in land-plants like *Sigillaria*, *Lepidodendron*, and some of the peculiar Devonian forms found by Dr. Dawson in Gaspé. Some of these latter forms have recently been detected by Mr. R. L. Jack in the course of the work of the Geological Survey in Perthshire.

The red and yellow sandstones, red clays, and red conglomerates and breccias, included under the term "Upper Old Red Sandstone," are copiously developed in Wales, in Ireland, and in the south of Scotland. In the two last-named regions they have been shown to lie unconformably on all older formations, there being a complete physical discordance, and an entire difference in organic contents, between these strata and the Lower Old Red Sandstone. In South Wales a less marked break in the series may be suspected from the cautious descriptions given by Sir Henry De la Beche. In the north of Scotland Sir R. Murchison has described the Upper as graduating downwards into the Middle or Caithness flags. In Caithness itself, however, and in Orkney, they are completely discordant, and the same relation may be inferred to hold elsewhere. This uppermost member thus bears the same relation to the Caithness flags as to the Arbroath flags. Wherever the top of the series can be seen, it is found to pass gradually and conformably into the base of the Carboniferous system. So thoroughly do these two series of deposits dovetail with each other that no sharp line can be drawn between them. If we work our way into the red rocks from the Carboniferous side, we may claim them as merely the base of the Carboniferous system. If we approach them from the side of the Old Red Sandstone, we may well regard them as a late and unconformable sub-division of this system.

The author next adverted to the fossils peculiar to the Upper Old Red Sandstone, calling attention to the continuance of land-plants and ganoid fishes as characteristic Old Red Sandstone features. He then, in conclusion, pointed out the physical geography which appears to be indicated by the deposits of this period. It is still possible to map out some of the terrestrial and lacustrine areas which then marked the site of Britain. Hill-ranges, still in existence, formed prominent features in the landscapes of that time, though with many differences of outline; in particular, with water-filled bays, straits, long fjord-like inlets and scattered lakes which have been filled

up with sandstones, conglomerates, and breccias. The red stain of these deposits, occasional pseudomorphs of rock-salt and layers of gypsum, combined with ripple-marks and sun-cracks seem, as Prof. Ramsay has suggested, to indicate the concentration of the saline waters which filled these basins; while further evidence of the unwholesome nature of the water may be indicated by the general paucity of fossils in the strata, and by the immense numbers of well-preserved fishes which are sometimes met with crowded into a small space, as if they had come from fresher water elsewhere, and had been inclosed and killed in scattered pools. The peculiar breccias and brecciated conglomerates of the Upper Old Red Sandstone have been compared to some recent Glacial deposits, and the resemblance has been pointed out between the form of the stones in these deposits, and those in common boulder-clay. It should be noted also that in many cases these breccias occur in old valleys, and bear many of the characters of valley-moraines. Such are those to the east of Ullswater, and those which flank, and in some places penetrate the Lammermuir Hills. In the latter district worn dome-shaped bosses of rock underlying the breccias recall the aspect of true *roches moutonnées*. Another glacial feature is suggested by the basin-shaped hollows (apparently sometimes true rock-basins) in which the deposits lie. Further indications of ice are given by the remarkable patches of angular and rounded stones scattered through the red sandstones of Arran, the occurrence and position of which may be accounted for on the supposition that they are portions of shore-gravel, which have been frozen and transported in cakes of floating-ice.

Indications of terrestrial disturbance during the accumulation of the Upper Old Red Sandstone in Scotland are furnished by the Lammermuir Hills. Towards the close of the period, and thence through the deposition of the Lower Carboniferous rocks, volcanic action which seems to have been quiescent for a long interval, broke out again over the south of Scotland. To this period belongs the chain of old lavas and tuffs which may be traced from the mouth of the Nith eastwards by Langholm and the Tarras Water, to the head of the Slitrig Valley, and through the plain of the Tweed as far northwards as the Whiteadder. The Garlton Hills, Campsie Fells, and the ranges of hills which run down Renfrewshire and the north-east of Ayrshire, and are prolonged into Bute, the Cumbrays and Arran mark a prolonged series of volcanic eruptions during this same period. Probably the terraced hills of Lorne are of similar age. Traces of contemporaneous volcanic action occur likewise in the Upper Old Red Sandstone of the north of Scotland, and form a remarkable feature in the cliffs of Hoy, one of the Orkney Islands.

The author brought forward evidence to show that while the Upper Old Red Sandstone was being deposited in the British area, there existed outside that area a sea in which some of the characteristic corals, brachiopods, and other organisms of the time of the Carboniferous Limestone already existed. He pointed out the intercalation of limestone bands in the Red Sandstone series in Arran and elsewhere, a long way below the base of the Cement-stone group which underlies the Carboniferous Limestone. These calcareous bands, full of species of fossils which are familiar in the Carboniferous Limestone, seem to indicate that while, on the whole, the Upper Old Red Sandstone, and the red strata at the base of the Carboniferous system were deposited under conditions unfavourable to the presence of at least corals, crinoids, and molluscs, their formation was interrupted by intervals during which clearer and less saline water prevailed, perhaps owing to the removal of barriers which allowed the access of the main ocean with its animal forms into the closed lagoons and inland seas of the Upper Old Red Sandstone.

ON REPULSION RESULTING FROM RADIATION[1]

THIS paper contains an account of experiments on the action of radiation on bodies the surfaces of which have their radiating and absorbing powers modified by various coatings. The difference between a white and a lamp-blacked surface in this respect was at first not very decided, and experiments have been instituted with the object of clearing up some anomalies in the actions observed. Two pith discs, one white and the other black, are suspended on a light arm in a glass bulb by means of a fine silk fibre; after perfect exhaustion the white and black discs are found to be equally repelled by heat of low intensity, such as from the fingers, warm water, &c. A copper ball is then tried at gradually increasing temperatures. Up to 250° C. it repels both equally, above that the black is more repelled than the white, and at a full red heat the repulsion of the black disc is very energetic. A lighted candle acts with more energy than the red-hot copper.

The presence of even a small quantity of aqueous vapour in the exhausted apparatus almost, if not quite, neutralises the more energetic action which luminous rays appear to exert on a blackened surface.

After describing several different modifications and some new forms of apparatus devised to facilitate experiment, the author gives a drawing of an instrument which enables him to get quantitative measurements of the amount of incident light falling on it. It consists of a flat bar of pith, half black and half white, suspended horizontally in a bulb by means of a long silk fibre. A small magnet and reflecting mirror are fastened to the pith, and a controlling magnet is fastened outside so that it can slide up and down the tube, and thus increase or diminish sensitiveness. The whole is completely exhausted and then inclosed in a box lined with black velvet, with apertures for the rays of light to pass in and out. A ray of light reflected from the mirror to a graduated scale, shows the movements of the pith bar. The degrees of deflection produced by the light of a candle at distances from 6 feet to 35 feet are given.

The experimental observations and the numbers which are required by the theoretical diminution of light with the square of the distance, are sufficiently close, as the following figures show:—

Candle	6	feet off	gives a deflection of	218°
,,	12	,,	,,	54
,,	18	,,	,,	24·5
,,	24	,,	,,	13
,,	10	,,	,,	77
,,	20	,,	,,	19
,,	30	,,	,,	8·5

The effect of two candles side by side is practically double, and of three candles three times that of one candle.

The action of various solid and liquid screens is next given.

A candle three feet off, giving a deflection of 180°, has its action reduced to the following amounts by

Yellow glass	... ...	161°
Blue	,, ...	102
Green	,, ...	101
Red	,, ...	128
Water	,, ...	47
Alum	,, ...	27

A candle on each side of the apparatus, and equidistant from it, keeps the index ray of light at zero; by shading off either one or the other the light flies off to either extremity of the scale. This gives a ready means of balancing two sources of light one against the other. Thus,

[1] Paper read at the Royal Society, Feb. 10, by William Crookes, F.R.S., &c. Part III.

retaining the standard candle 48 inches off, on the left of the bar, the index is brought to zero by placing on the right

2 candles	67 in. off.
1 candle behind solution of sulphate of copper	6 „
„ „ alum plate	14 „
A small gas burner	113 „

These experiments show how conveniently and accurately this instrument can be used as a photometer. By balancing a standard candle on one side against any source of light on the other, the value of the latter in terms of a candle is readily shown; thus in the last experiment the standard candle 48 inches off is balanced by a gas-flame 113 inches off. The lights are therefore in the proportion of 48^2 to 113^2, or as 1 to $5\frac{1}{2}$. The gas-burner is therefore equal to $5\frac{1}{2}$ candles.

By interposing screens of water or plates of alum, and so cutting off the dark heat, the actual luminosity is measured. In addition to this, by interposing coloured glasses or solutions, any desired colours can be measured either against the total radiation from a candle, its luminous rays, or any desired colour. One coloured ray can be balanced against another coloured ray, by having differently coloured screens on either side.

The variations in the luminosity of a "standard" candle will cease to be of importance. Any candle may be taken; and if it be placed at such a distance from the apparatus that it will give a uniform deflection, say of 100 divisions, the standard can be reproduced at any subsequent time; and the burning of the candle may be tested during the photometric experiments by taking the deflection it causes from time to time, and altering its distance, if needed, to keep the deflection at 100 divisions.

If the pith bar in this instrument be blacked on alternate halves, an impetus given by a ray of light always acts in the same direction of movement. A candle causes it to spin round very rapidly until the suspending fibre is twisted up, and the rotation is stopped by the accumulated torsion.

By arranging the apparatus so that the black and white surfaces are suspended on a pivot instead of by a silk fibre, the interfering action of torsion is removed, and the instrument will rotate continuously under the influence of radiation. To this instrument the author has given the name of the "Radiometer." It consists of four arms of very fine glass, supported in the centre by a needle-point, and having at the extremities thin discs of pith lamp-blacked on one side, the black surfaces all facing the same way. The needle stands in a glass cup, and the arms and discs are delicately balanced so as to revolve with the slighest impetus.

In the "Proceedings of the Royal Society" last year, the author gave a brief account of some of the earlier experiments with these instruments. In the present paper he enters very fully into the various phenomena presented by them, and gives Tables showing the number of revolutions made by the radiometer when exposed to a constant source of light removed different distances from the instrument. The law is that the rapidity of revolution is inversely as the square of the difference between the light and the instrument.

When exposed to different numbers of candles at the same distance off, the number of revolutions in a given time are in proportion to the number of candles, two candles giving twice the rapidity of one candle, and three, three times, &c.

The position of the light in the horizontal plane of the instrument is of no consequence, provided the distance is not altered; thus two candles, one foot off, give the same number of revolutions per second, whether they are side by side or opposite to each other. From this it follows that if the radiometer is brought into a uniformly lighted space it will continue to revolve. This is proved to be the case by experiment.

The speed with which a sensitive radiometer will revolve in full sunshine is almost incredible. Nothing is visible but an undefined nebulous ring, which becomes at times almost invisible. The number of revolutions per second cannot be counted, but it must be several hundreds, for one candle will make it spin round forty times a second.

The action of dark heat (*i.e.*, from boiling water) is to repel each surface equally, and the movement of the radiometer is therefore arrested if a flask of boiling water is brought near it. The same effect is produced by ice.

From some observations made by the author, it appears probable that heat of a still lower refrangibility repels the white more than it does the black surface. Many instances are given of the radiometer revolving the reverse way. Thus, breathing gently on the instrument will generally cause this effect to be produced.

An experiment is described with a radiometer, the moving parts of which are of aluminium, blacked on one side. When exposed to the radiation from a candle, the arms revolve the normal way. On removing the candle they revolve the reverse way. Heated with a Bunsen burner the arms revolve the normal way as they are getting hot, but as soon as the source of heat is removed and cooling commences, rotation sets up in the reverse way, and continues with great energy till the whole is cold. It appears as if the reverse movement during the cooling is equal in energy to the normal movement as it is being heated.

It is easy to get rotation in a radiometer without having the surfaces of the discs differently coloured. An experiment is described with one having the pith discs blacked on both sides. On bringing a candle near it, and shading the light from one side, rapid rotation is produced, which is at once altered in direction by moving the shade to the other side.

The author describes many forms of radiometer, by means of which the movements can be exhibited to a large audience, or can be made to record themselves telegraphically on a self-recording instrument.

THE WATER SUPPLY OF THE METROPOLIS

IN the concluding portion of his anniversary address printed in the last number of NATURE (p. 376), the late president of the Geological Society severely criticises the proposal of the Rivers Commissioners to supply London with pure spring water. The Commissioners advise that the drinking water of London should continue to be derived from its present sources, but that it should be led away to its destination before it is mixed with the sewage of Oxford, Reading, Windsor, and other towns, and before it is fouled by the filthy discharges of paper mills and by other disgusting refuse.

Mr. John Evans thinks that it can hardly be believed that such a proposal as this should have been brought forward, involving, as he believes it would, if carried out, the conversion of the "fertile meadows" of the Thames Valley into "arid wastes," and the utter destruction of "watercress beds, now of fabulous value;" he adds that "even the canals and navigable rivers will become liable to sink and be lost in their beds." In predicting these dire results, he doubts whether his "judgment is *seriously* distorted," although he admits being deeply interested in the water power of one of the threatened valleys, and protests that no one can submit silently to an insidious (?) attack upon his property.

Having carefully studied for many years the hydrographical features of the Thames and other valleys, I have no hesitation in saying that Mr. Evans's fears are, for the most part, entirely unsupported by experience. Sterility

of surrounding land has not accompanied the withdrawal of vast volumes of water from the deep wells at Deptford, Thames Head, Caterham, Canterbury, Watford, Tring, or Lichfield, and it is singular that Mr. Evans should have overlooked the fact that moisture is supplied to growing plants from above and not from below. However numerous the wells of a given district may be, the rain must still fall upon the surface of, and soak through, the land before it can reach them.

As the *dry-weather* flow of the Thames even above Teddington lock is 600 millions of gallons daily, it would be waste of time to discuss seriously the possibility of canals and navigable rivers sinking into their beds in consequence of the abstraction of about one-eighth of that volume from springs and deep wells in that portion of the river basin. With regard to the water-cress interest, it is true that the Rivers Commissioners have not been so deeply impressed as Mr. Evans with the stupendous importance of this department of Thames agriculture, but it can scarcely be doubted that a wealthy city, containing 4,000,000 of inhabitants, would be able and willing to pay for any damage which it might inflict upon this or any other branch of industry.

The two most disgusting impurities revealed by the microscope in Thames water, as delivered for dietetic purposes in London, are the fibres of partially digested flesh meat, and those of variously coloured rags. The presence of these objects in our potable water clearly indicates the two chief kinds of *insoluble* polluting matter cast into the Thames, although chemical analysis cannot always trace to its sources the *dissolved* animal and vegetable impurities which it finds accompanying these insoluble materials. The question raised, therefore, is simple enough :—Shall the inhabitants of this "overgrown city," as Mr Evans contemptuously terms it, drink the pure spring water which nature offers them in singular abundance in the Thames valley, or shall they not be permitted to taste this sparkling beverage until the paper manufacturers, in the exercise of what they call their rights, have washed their filthy rags in it, and half a million of people have polluted it by their drainage?

It is remarkable that whilst Mr. Evans shows so much consideration, in his presidential address, for the pockets of the watercress-growers, he has so little to bestow upon the inhabitants of the overgrown city, for he does not hesitate to propose that the latter should encounter the expense of two separate water services—one (pure) for dietetic, and a second (polluted) for other domestic purposes. Now, leaving out of consideration altogether the risk of the polluted water being often used for dietetic purposes instead of the pure, and the enormous cost and inconvenience of laying and maintaining a new set of water-mains throughout the hundreds of miles of London streets ; the supply of each house with a new water service, together with the necessary alterations of the old pipes, could not cost, on the average, less than 4*l*. In February last 523,801 houses were supplied with water by the eight metropolitan companies, and we have consequently here an expense of more than 2,000,000*l*. Surely a very small fraction of this sum would suffice to buy up any injured watercress-growers, even at "fabulous" prices.

In their sixth report, the Rivers Commissioners of 1868 state that the basin of the Thames, including that of its tributary, the Lea, is upwards of 5,000 square miles in extent. Rather more than one half of this area, including the oolitic and cretaceous formations, is covered by a porous soil upon a permeable water-bearing stratum, the remainder being occupied by the Oxford, Kimmeridge, gault, and London clays. The annual rainfall of this district averages about 28 inches, or 5,217 millions of gallons per day. Two-thirds of this vast volume of water is lost by evaporation, while, of the remaining one-third, one-half passes away in floods, and the other half only is at present available for springs and deep wells. But even this small fraction amounts to 870 millions of gallons daily, and it is proposed to take for the supply of the metropolis only 120 millions of gallons after it has practically performed all its fertilising functions ; whilst, of this volume, there is even now supplied to London, in dry weather, about twenty-two millions of gallons. It is highly probable, however, that the volume of water available at present for springs and deep wells could be augmented to an extent commensurate, or nearly so, with the amount so abstracted for the supply of London. The chalk, and to some extent the oolite of the Thames basin, constitute an immense sponge which sops up the water falling upon it and maintains it, partly by capillary attraction and partly by its resistance to flow, at considerable elevations above the nearest rivers. This sponge has been aptly likened by Mr. Thornhill Harrison to an inverted reservoir, and just as the dry-weather flow of the Thames and its tributaries could be augmented by the judicious use of artificial storage reservoirs, so could the total yield of spring water from this vast natural reservoir be increased, by artificially bringing the water in it to a lower level before the occurrence of the autumn and winter floods. The spongy reservoir would thus be rendered capable of receiving those heavy rainfalls which, at present unable to find storage room below, either run off the saturated surface and constitute the winter floods, or immediately displace a corresponding volume of spring water from the sponge forcing it into the Thames and its affluents.

In the concluding paragraphs of his address Mr. Evans tries to show, from the results of chemical analysis, that the polluted water of the Thames is purer than the spring water from the chalk, and he thus seeks to make the inhabitants of the metropolis content with their present supply. His statements on this subject are founded upon an entire misconception of the meaning of the analytical results. A most exhaustive chemical examination of the river waters of the Thames basin, on the one hand, and of the spring and deep-well waters on the other, has shown, in the most unmistakable manner, the immense superiority of the latter for dietetic purposes. Indeed, it is obvious that, even with the most efficient river conservancy imaginable, aided by the best efforts of the Legislature, the Thames must always receive so much pollution as to render its use for the supply of the metropolis highly objectionable. No preventive measures can hinder the washings of highly-manured land, the excrements of cattle, the imperfectly purified sewage of towns and villages, and the partially cleansed discharges from paper-mills, skinneries, and tanyards, from mingling with the stream in enormous volumes. Such matters, though not obviously offensive to the senses (when this highest practical stage of purification has been reached), are still, from a sanitary point of view, of a very dangerous character. But even if this were not so, and if fatal results had never been known to follow the domestic use of such water, the refined feeling which separates the civilised man from the savage, and which excites loathing at the bare idea of organic matter, which has recently formed part of a human body, being supplied for human consumption, ought here to assert itself, and secure the rejection of such a beverage.

E. FRANKLAND

SCIENTIFIC NOTES TAKEN IN THE HIMALAYAS

I.—*Atmospheric Absorption.*

THE following notes refer chiefly to spectroscopic work, and they are, I think, of interest, as they show the importance of establishing a regular series of similar observations at different points of the globe.

Prof. Vogel has lately published in Poggendorff's *Annalen* the results of his observations taken in the Red Sea and in the Indian Ocean. He comes to the

conclusion that the relative intensity of the blue and red end of the solar spectrum is subject to great variations, variations which do not seem to stand in a simple relation to the hygroscopic state of the atmosphere or to barometric pressure. My results, while entirely confirmatory of those of Vogel, point to the fact that in the higher regions of the Himalayas, and at the season the observations were made, atmospheric absorption takes place chiefly in the red end of the spectrum. The blue end of the solar spectrum, even when the light of the sun has passed through a cloud, is remarkably bright.

The following extract from my note-book will place this fact beyond doubt. The observations were conducted at Simla with a spectroscope of eight prisms of about 60°. The direct sunlight was reflected by means of a small mirror into the slit. The slit was generally adjusted until one line between D_1 and D_2 was distinctly seen. As far as I could judge, all the lines, but not more than those given in Angström's map, were seen. The rainy season had just begun, but had not yet appeared in the violent way it did after my departure from Simla :—

Extract from Note-book.

June 27, 8 A.M.—B beautifully shaded. Light visible in the blue as far as wave-length 4040, and most likely further, but the telescope cannot be moved to greater deviation.

9 A.M.—Space beyond B closes up, while in the blue the spectrum is as visible as before.

Red end closes up. Blue perfectly visible.

11.15 A.M.—The red closed up still more. The blue as clear as before.

The sky is beautifully blue, but a slight halo seen round the sun.

July 3, 5.30 P.M.—The atmospheric lines near D seen distinctly. The blue is exceptionally clear and visible as far as H. Sky rather cloudy, and halo round the sun.

6.30 P.M.—Sun very near horizon. Spectrum seen from C to G.

In judging on the visibility of the spectrum, it should be borne in mind that, owing to the great number of prisms, a great part of the absorption in the blue was due to the glass, and that, therefore, owing to the great dispersion in the blue and instrumental absorption, the blue was seen under peculiar disadvantage. The above are only a few out of many observations. I have observed the passage of a cloud in front of the sun without any apparent effect in the blue, while the red end was all cut off.

I was at the same time struck by the fact that the peculiar redness of the clouds in the evening, which we observe so often in our climates, was only rarely seen, and when seen the colour was rather yellow than red. On making this remark to a friend competent to judge, and who through a repeated sojourn in Simla was enabled to form an opinion, I heard that the redness of the sky at sunset was often and beautifully seen at the end of, and after the rainy season.

I now pass to a few observations which I have made in Upper Thibet, a country which lies beyond the range of the rainy season. The observations all point to the remarkable clearness in the blue. As I have said, the hygroscopic state of atmosphere, as measured by the wet and dry bulb or barometric pressure, cannot alone account for all the phenomena. I find, for instance, that the presence of vegetation affects the atmospheric absorption in a remarkable degree. In the Kyan Chu plain, for instance, the plateau on which I observed the mirage described in NATURE (vol. xiii. p. 67), objects at ten miles distance look as sharp and distinct as those half a mile off. It is, in fact, impossible to judge of distance. Crossing the Tagalung Pass (18,000 feet), we descended from that plain into the valley of the Indus. As soon as we reached vegetation, at a distance of only two marches from the above-mentioned plain, and at height still above 12,000 feet, the whole aspect of the country is a different one. Distant mountains now take that lofty blue colour which gives such peculiar charm to the landscape. In the evenings especially you cannot help knowing that there is something between your eye and a distant object which affects its colour and distinctness, and through it you get a standard for judging distances. Without vegetation, even at a lower height, as, for instance, in the valley of the Bagha (Lahoul), you seem to look through a vacuum. In the upper part of the valley of the Indus, of which I am now speaking, I have not seen that clearness in the atmosphere which I have invariably seen in Switzerland at a height of 3,000 feet. The strong radiating power of the sun, which stands much more vertical in India, is evidently the cause of this, for it can only be organic matter floating in the atmosphere which can produce such a striking result. That the absence of any rain or deposit of any kind must not be left out of account is clear. The air in the side valleys of Cashmere, although rich in vegetation, is particularly transparent. Strange enough the principal valley of Cashmere, *i.e.* the valley of the Jehlum, is generally hazy, although there is a good deal of rain.

I have seen the planet Mars look almost white ; Jupiter and the other stars at that time had a bluish tint.

II.—*Glaciers.*

On the maps of Upper Thibet one finds a great many glaciers marked down. From my knowledge of glaciers I would not have given to these frozen masses of snow the name of glaciers. On inquiring further into the matter, I find that from measurements made by Schlagintweit these so-called glaciers have only very little, if any motion ; and judging from what I have seen and heard, I should say they must be only half-formed glaciers. The cause of this seems to me to be the want of pressure above the glaciers. In a country where the snow line is 19,000 feet high, and in which the mountains are seldom over 21,000 feet—for such is the country I am talking of—there cannot be a sufficient pressure to convert the snow into a clear mass of ice. I am however told that there is in Spiti one, but only one, glacier which deserves the name.

III.—*Temperature of the Blood.*

I am sorry that my observations on the temperature of the blood were cut short by untimely breakage of the thermometers. I have taken, however, a few observations in the plains of India, when the temperature of the air was higher than that of the blood. In a temperature of about 100° the blood was little above 98°.

IV.—*Parhelia.*

According to received opinions, parhelia are due to the refraction of light through crystals of ice. If this explanation is correct, and there seems to be no reason to doubt it, the following observations are of interest, as they show that even at the equator ice-clouds exist, and that parhelia are more often seen in India than in England. I have only once been lucky enough to see a parhelion in England, and that was since my return from India. In tropics and in the Himalayas I have seen within four months, eight times a rainbow-coloured ring round the sun. Its distance from the sun could only be measured by rough means, but it seemed to me to be larger than the generally given value of 22°, although near it. I subjoin the various observations :—

1. May 3.—Near Singapore, about sixty miles north of equator, at 5 o'clock P.M., part of a rainbow-coloured ring was seen, with the sun as centre. It stood on the white edge of a dark cloud.

2. Aug. 1.—At Dwara, in the Kulu Valley, almost the exact reproduction of the above phenomenon was seen on a cloud hanging on the side of a mountain. It was during the rainy season, at a height of about 5,000 feet. Weather rather hot.

3. Aug. 3.—Near the top of the Rotang Pass (13,000′), about 9 o'clock A.M., the lower half of a beautifully-coloured ring was seen for about half an hour.

4. Aug. 5.—Gondla (10,000′). At 3 P.M. a beautifully-coloured ring round the sun was seen on a very thin film of clouds in front of the sun. The blue was most distinct, and much purer than in the common rainbow.

5. Sept. 19.—While going down the Jehlum in a boat from Islamabad to Srinagur, I saw in the river the reflection of part of a coloured ring. Looking directly at the cloud, I saw the ring again on the white edge of a cloud. The sun was nearly setting.

6. Sept. 23.—At Baramula, at 4 P.M., I saw the same ring described above most distinctly, and making a complete circle round the sun.

7.—Marching out of Cashmere I was struck one morning by the appearance of the cloud being nearly the same as when I had before seen the circle in question. On looking carefully I could indeed see a faint trace of the ring.

8. Oct. 6.—At Peshawur (Punjab) I saw to the right of the setting sun about the sixth part of the coloured ring.

ARTHUR SCHUSTER

VISIT OF THE CHEMICAL SOCIETY TO THE ROYAL ARSENAL

IN response to an invitation from its president, Prof. Abel, F.R.S., the chemist of the War Department, nearly 500 Fellows of the Chemical Society visited the Royal Arsenal at Woolwich on Tuesday last. The presidents of most of the learned societies, together with other eminent men of science, were included in Mr. Abel's liberal invitation, so that during the day a constant stream of visitors flowed through the interesting workshops at Woolwich.

Beyond the ordinary attractions of the establishment, Mr. Abel had arranged to demonstrate the more important applications of science to warfare, and among these were included some experiments with gun-cotton and other explosives, the study of which he has made peculiarly his own. Indeed, the most attractive part of the programme from a scientific point of view was that carried out on the outskirts of the arsenal in the vicinity of the proof butts, where operations commenced by the firing of the big 80-ton gun. Col. Younghusband, F.R.S., R.A., the Superintendent of the Royal Gun Factories, as well as other heads of departments, had entered warmly into the spirit of the visit, and took considerable pains that every opportunity should be given the Fellows of witnessing the capabilities of this monster weapon. A charge of 250 lbs. of gunpowder, the grains of which measured nearly two inches cube, was introduced into the gun, and then the heavy bolt, or projectile, weighing 1,260 lbs. was rammed home. Those who were privileged to enter the chronoscope room, which is so small unfortunately, that scarcely a score of visitors could find room in it, were gratified with a sight of Boulanger's instrument for calculating the velocity of a cannon-ball in its flight, and as the thundering discharge was heard, this delicate apparatus proclaimed, simultaneously, that the projectile had been sent on its way at a velocity of nearly 1,500 feet a second, an impetus, it is said, sufficient to make a hole through the *Inflexible* iron-clad, with her twenty inches of armour and thick teak backing. The Boulanger instrument is easily explained. Placed in front of the gun, at an interval apart, are two wire screens, so arranged that the projectile in its flight tears through them one after another. From two magnets attached to the instrument hang two metal rods, and the instant the first wire screen is torn by the shot, a current of electricity is broken and the first of these rods falls. As No. 1 is in the act of falling, however, the second wire screen is broken by the shot releasing No. 2 rod, and this sets in action a trigger which strikes No. 1 rod before it has yet completed its fall. If the shot has been slow in travelling from one screen to another, then rod No. 1 has, naturally enough, nearly fallen its entire length before it receives a stroke from the trigger; and the higher the mark is upon the rod No. 1, or in other words, the more it has fallen the less rapid has been the passage of the shot. After the mark is made one has merely to refer to a scale to get the velocity.

After the firing of the 80-ton gun came the gun-cotton programme, which Mr. Abel and Mr. E. O. Brown had arranged for the purpose of demonstrating in the first place the peculiar qualities of this explosive, and secondly its application to war purposes. To quote from this programme, Mr. Abel first gave "illustrations of some of the conditions which promote detonation of an explosive agent by a blow, or by the force exerted by an *initial* detonation." It was shown that gun-cotton refused to detonate except under very special circumstances, that is to say, neither a confined charge of gunpowder nor a small charge of unconfined mercuric fulminate brought about that result, which was only effected by a confined charge of fulminate, or by other masses of gun-cotton being detonated in its immediate vicinity.

Mr. Abel then went on to demonstrate the high speed at which detonation travels, the same being faster than any known agent, if we except electricity and light. A row of gun-cotton cakes half an inch apart, 36 feet long, was detonated at one end, and by crossing the row with several insulated wires connected with Noble's chronoscope (the wires being broken one after the other, as the detonation proceeded), it was proved that the velocity of the detonation exceeded 18,000 feet per second.

But it was the last of the gun-cotton experiments which proved the most interesting to the general body of visitors, as they illustrated the important uses of this valuable explosive. In these trials the gun-cotton was employed for the most part in a *wet*, and therefore *uninflammable* state, in which condition it detonates just as readily as when dry, provided a small charge of desiccated cotton is used to start the action. First of all, the value of detonation was shown in connection with cavalry raids in an enemy's country. Provided with a few pounds of gun-cotton and some fulminate fuses, a trooper might cut half-a-dozen lines of railway with very little ceremony, for, as Mr. Abel plainly showed, an eight ounce cake of the material exploded upon a rail, fractured the metals so completely as at once to block the line. In the demolition of wooden stockades, such as have caused us some difficulty in Perak lately, gun-cotton was shown to be equally efficacious, for a charge of wet cakes placed at the foot of such a structure on Tuesday last, levelled the same to the ground far more quickly than it takes to tell of the incident. Finally, a torpedo was fired under water constructed in the most primitive manner, by simply filling a large potato-net with gun-cotton slabs, and throwing it bodily into the water, a fuze and dry primer being contained in the middle of the charge.

After lunch, which the president had hospitably provided for his numerous guests, and at the close of which Dr. Hooker, C.B., P.R.S., took the opportunity of thanking Mr. Abel for the intellectual treat he had provided them with, the visitors had the satisfaction of witnessing the process of big gun making, a forging of fifty tons of glowing metal (the coil of one of the 80-ton guns) being worked under the monster 40-ton steam-hammer for their especial behoof.

The last sight of all was certainly not the least interesting. It was the run of a Whitehead torpedo under water, the machine, as our readers may know, being shaped in the form of a cigar and propelled through the water, rocket-fashion, by means of compressed air, which issues from its tail. The passage of this submarine monster the whole length of a canal, termed the torpedo

range, brought to the close a day which the fortunate Fellows of the Chemical Society will certainly remember as one of the most instructive and enjoyable in their varied experiences.

NOTES

IT is with the greatest regret that we announce the death of Col. Strange, the Inspector of Instruments to the Indian Government, who died on the 9th instant. We shall give an obituary notice next week.

AN impression has become general, through the statements of our contemporaries, that the Sub-Wealden boring has been permanently stopped. This is not the case; for at the last meeting of the committee it was determined to carry it on to a depth of 2,000 feet, and if funds continue to flow in with the success which has previously characterised this movement, the boring, it is hoped, will be carried to the greatest depth attainable. The boring has now reached a depth of more than 1,900 feet, and was to be recommenced this week; should, however, a greater depth than 2,000 feet be determined on, it will be necessary to enlarge and reline the hole, which will cost from 600*l.* to 700*l.* Arrangements are being made by which it is hoped that a continuous core may be obtained from the present depth to that of 2,000 feet. We believe the Government grant of a pound a foot for each foot bored ceases at 2,000 feet, and, looking to the important light the prosecution of this boring will throw, not only on many theoretical questions of modern science, but on so many doubtful points of practical interest to England, it is sincerely to be hoped that the advisability of continuing the grant will be seriously considered by her Majesty's Ministers.

WE have received from Messrs. Allsopp and from Dr. Hassall letters referring to the statement noticed in our review of the work of the latter on Food (vol. xiii. p. 345), that the water used by the former in the brewing of their ales contains 7·65 grains of sulphate of zinc. Dr. Hassall expresses great annoyance that through some inadvertence on his part this unfortunate error, as it obviously is, should have been allowed to get into his book. He points out, what no doubt would be evident to most readers, that sulphate of *zinc* is a mistake for sulphate of *potash*. He assures us that no trace of so deleterious a substance as sulphate of zinc has been found in the water used by Messrs. Allsopp, and that their celebrated bitter beer consists solely of the products of malt and hops, and the constituents of pure spring-water. A further letter from Dr. Hassall, for which we have not space, will be found in our advertisement columns.

WE are informed that Mr. J. E. Harting is engaged in editing for the "Transactions of the Norfolk and Norwich Naturalists' Society" ten unpublished letters of Gilbert White, which have recently come to light. The originals are in the possession of the Rev. H. P. Marsham, of Rippon Hall, near Norwich, and are addressed to his great grandfather, Mr. Robert Marsham, F.R.S., of Stratton Strawless, Norfolk. It is expected that this interesting publication will appear about the end of this month or early in April.

MR. STANFORD has sent us specimens of some very fine maps recently published by him. Two of these are Orographical maps of Europe and of England, and the public in general and educationists in particular ought to be grateful to Mr. Stanford for thus putting within their reach a style of map which has hitherto been peculiar to Germany. The maps are really admirable specimens of a very difficult kind of cartography, and we have only one fault to find with them. Unfortunately, the midland levels are coloured green, while the sea is coloured blue, so that by gaslight the boundary cannot be distinguished. Why not have the nearest approximation to sea-level coloured white, the various higher levels of the land graduated shades of brown, and those of the sea by various shades of blue or green? This would be a simple and, we think, most intelligible plan. If the slight defect we mention—and it is only noticed under artificial light—were remedied, the maps would be nearly all that could be desired. The third map is a large-scale one, in four sheets, of British Guiana. The map is compiled from the surveys executed under H.M.'s Commission for 1841-44, and under the direction of the Geographical Society, for 1835-39, by Sir R. H. Schomburgk, revised and corrected to the present time by Mr. Cathcart Chalmers, Crown Surveyor of the Colony, and Mr. J. Gay Sawkins, Director of the Geological Survey of the West Indies and British Guiana, with additions by Mr. C. B. Brown. It will thus be seen that the map has been constructed on the latest and most trustworthy authorities. It is a curious fact that the boundaries between British Guiana and Venezuela on the one hand and Brazil on the other have never been properly adjusted.

WE have received a very important letter by Mr. Russell Government Astronomer at Sydney, which we regret that we have not space to reproduce *in extenso*. The letter refers to the excessively dry weather of Australia, which, indeed, has been so dry as to be really alarming, and reviews the results of rainfall observations made at Sydney during the last thirty-six years. This letter suggests to us that the unusual wet weather we have had here may be more than compensated by the excessively dry weather which has prevailed in Australia.

THE Duke of Richmond and Gordon stated in the House of Lords no Tuesday that the Vivisection question was under the consideration of the Government, but he could not say when any legislation would take place upon it.

A FEW days ago a meeting was held in Birmingham for the purpose of establishing a Philosophical Society, and it was found that the proposal met with very warm support. Some difference of opinion was expressed as to the propriety of including literary subjects in its programme, but the general feeling was in favour of keeping to a purely scientific course. A society of this kind is greatly wanted in this important centre, for science is represented there only by the Natural History Society, which, though it has done some good work, is found to have too limited a scope. With the prospect held out by the munificent founder of Mason's College for advanced scientific culture, there can be little doubt that such a society would do great good, and we wish it every success. A proposal for amalgamating the Natural History Society with the new Society has been made, and has been favourably entertained.

MR. R. W. CHEADLE is announced as having been successful in excavating from the well-known brick earth pit at Crayford a bone which was identified by Prof. Morris as the thigh-bone of a British species of lion. Mr. Cheadle found at the same time several rhinoceros' teeth in this cemetery of ancient life among the hop gardens of Kent.

PETERMANN'S *Mittheilungen* for March contains several important papers. H. Habenicht contributes a brief description to accompany a carefully, and notwithstanding its size, remarkably clear map of Europe, showing the distribution of the sedimentary rocks on that continent. A map of South New Guinea between 142° and 143° E. long. shows the course of the recently discovered Baxter River, accompanying which are accounts of the Macleay expedition and of Macfarlane and Stone's exploration of the Baxter River or Mai-Kassa. Lieut. Weyprecht continues his "Sketches from the Far North," in this part treating of the ice-pressure. The account of Lieut.-Col. Przewalsky's

travels in Mongolia and the Land of the Tunguts is continued also.

AT Monday's meeting of the Royal Geographical Society, the principal business was the reading of papers on the interior of New Guinea, by Mr. Stone and Mr. Macfarlane. The writers had found the coast district of New Guinea too barren "even for the cultivation of the banana," but concurred in stating that the country improved considerably as they travelled inland. There they found great fertility, a kind, hospitable people, and a country comparatively free from fever, whereas the coast was barren, the people were morose and warlike, and the climate was destructive of the health of Europeans.—No communication was made respecting Lieut. Cameron, but it was understood that at the last advices he was with his party at Loanda.

THE general staff of the German empire has published a report of experiments made in Germany on ballooning at the expense of the Imperial Government. The conclusions throw no new light on the subject, but the German officers believe that the mechanical direction of balloons is by no means an impossibility. They even suppose that the problem of ascending or descending without using ballast or the valve, is very likely to receive a speedy solution. They propose to the Government to determine by means of experiments what is the best diameter for the helix when it is applied to a balloon of a certain capacity. They propose also to try the efficacy of wings for propelling balloons. They are not of the common opinion that the diameter of balloons can be indefinitely enlarged.

MISS SHEEPSHANKS has presented to the Royal Astronomical Society 200 volumes of works on Astronomy, some of them very rare; and Lord Lindsay has presented a large and valuable collection of the late Mr. Carrington's MSS. on the subject of sun-spots.

AT the last regular meeting of the Berlin Geographical Society, Herr Kiefert read a paper on the African Expedition of Lieut. Cameron, which he described as epoch-making, and declared that the general results were the most important since Livingstone.

THE Museum of Paris has lost the services of two of its most eminent professors, M. Milne-Edwards in zoology, and M. Delafosse in mineralogy; they have been placed on the retired list on account of old age. M. Milne-Edwards has been succeeded by his own son, a promising naturalist, and M. Delafosse, by M. Decloizeaux, a member of the Institute.

ON the 4th inst. the Berlin University held an extraordinary meeting to celebrate the fiftieth anniversary of the day on which Prof. Dove was received a doctor. An address was handed to him by Professors Mommsen and Du Bois-Reymond. The Minister of Public Instruction was present, and a magnificent vase was presented to Dr. Dove on behalf of the Emperor of Germany. In the evening a banquet took place at the English Hotel. Among those present were Prof. Helmholtz and a number of other German scientific notabilities.

THE Société Française de Navigation Aérienne has awarded a gold medal and diploma "for devotion to science," to Mr. F. W. Brearey, honorary secretary to the Aeronautical Society of Great Britain.

THE change of Ministry has been completed in France, and M. Wallon is no longer the Minister of Public Instruction. The learned gentleman left behind many warm sympathisers. His successor appointed last Friday is Mr. Waddington, an Englishman by parentage, born in France in 1828, naturalised a Frenchman, and a member of the Senate, but a Protestant by religion, and educated at Rugby and Cambridge. Great efforts are likely to be made to secure for France competent representation at the forthcoming Scientific Loan Exhibition.

THE Cambridge Museums and Lecture-rooms Syndicate report the urgent necessity for increased accommodation in the departments of zoology, comparative anatomy, and physiology, and recommend that steps be at once taken to supply the want. They suggest the erection of a building on a site adjacent to the present museums, to consist of three floors, with cellars under the central portion.

M. HARENT, the director of a private institution, is now the President of the Municipal Council of Paris. He has deposited a formal proposition asking the Council to establish several meteorological observatories for the analysis of rain, water, air, electrical determinations, and ordinary barometer and temperature readings. All these establishments are to be modelled after that of Montsouris, but on a smaller scale.

THE Daily *Bulletin* of Weather Reports for March 1873 issued by the chief signal officer of the War Department of the United States, has been received. The publication gives on a reduced scale the whole of the tri-daily weather maps for the month, each map being accompanied with (1) the synopsis of the weather conditions, and (2) probabilities of the weather during the next twenty-four hours, drawn from these conditions, and stated on each map at the time of its publication, together with (3) a statement of the actual facts as they occurred with which the "forecasts" of the office may be compared. This fearless and straightforward course of exhibiting equally its successes and its failures, is deliberately adopted by the office in order to facilitate inquiry by scientific men, into the theories and causes which have led to these successes and failures, from which inquiries the practical work of the office cannot fail to reap most substantial benefit.

THE additions to the Zoological Society's Gardens during the past week include 171 Sand Lizards (*Lacerta agilis*) from Italy, presented by Mr. H. Negretti; two Forster's Milvagos (*Milvago australis*) from the Falkland Isles, presented by Lord Lilford; a Great Frigate Bird (*Frigata aquila*) from America, three Black-backed Geese (*Sarcidiornis melanota*) from India, a Gull-billed Tern (*Sterna anglica*), European, a Crested Hangnest (*Ostinops cristatus*), a Cayenne Lapwing (*Vanellus cayennensis*) from South America, an Ogilby's Rat Kangaroo (*Hypsiprymnus ogilbyi*), a Vulpine Phalanger (*Phalangista vulpina*) from Australia, purchased; a Jackal Buzzard (*Buteo jacal*) from Africa, deposited; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*).

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Feb. 3.—On Formulæ of Verification in the Partition of Numbers, by J. W. L. Glaisher, M.A., F.R.S.

Feb. 17.—"Researches upon the Specific Volumes of Liquids." By T. E. Thorpe, Ph.D., F.R.S.E., Professor of Chemistry in the Yorkshire College of Science, Leeds.

II. *On the Specific Volumes of certain similarly-constituted Inorganic Chlorides.*

The results of the observations made by Pierre and Kopp upon the boiling-points, specific gravities, and thermal expansibilities of the trichlorides and tribromides of phosphorus, arsenic, and antimony, have led Kopp to suppose that the specific volumes of phosphorus, arsenic, and antimony, in their liquid combinations, may be identical. The same conclusion has been drawn with respect to tin, titanium, and silicon from Pierre's observations upon the tetrachlorides of these elements.

The common value of P, As, and Sb would appear to be about 27, that of Si, Ti, and Sn about 35. But on examining the details of the observations, it becomes evident that this conclusion is not strictly borne out by the results; the numbers obtained for the individual members of the group differ in many cases considerably from the common value, the divergences being far wider than could arise from errors of observation, either in the determination of the physical constants or in the estimation

of the atomic weights of the constituent bodies. In fact the order of the divergences would seem to render it probable that the specific volumes of the several members of a family of elements increase with their atomic weights.

In a former communication to the Royal Society the author has given the results of a series of observations on the specific gravities, boiling points, and rate of expansion of certain liquid chlorides of phosphorus. Since Roscoe has shown that vanadium is a member of the phosphorus group of elements, it appeared to him that a comparison of the specific volumes of the analogously constituted phosphoryl and vanadyl trichlorides might serve to throw additional light on this question of the relation of the specific volumes of the members of a family of elements to their atomic weights.

Three determinations of specific gravity of phosphoryl trichloride made with different bottles gave a mean number of 1·71185 at 0° compared with water at same temperature; compared with water at 4° the specific gravity is 1·71163.

The rate of expansion of phosphoryl trichloride from 0° to its boiling-point may be accurately represented by the expression—

$$V = 1 + 0{\cdot}001\,064\,309t + 0{\cdot}000\,001\,126\,66t^2 + 0{\cdot}000\,000\,005\,299t^3.$$

Its specific gravity at 107·23 is 1·50987; hence its specific volume $= \frac{153{\cdot}38}{1{\cdot}50987} = 101{\cdot}58$.

The results obtained with the dilatometer in the case of vanadyl trichloride may be represented by the formula

$$V = 1 + 0{\cdot}000\,965\,236t + 0{\cdot}000\,000\,898\,26t^2 + 0{\cdot}000\,000\,003\,191\,63t^3.$$

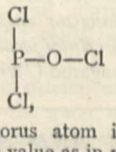
The mean of three experiments gives the specific gravity of vanadyl trichloride at 0°, compared with water at 4°, as 1·86527.

The specific gravity of vanadyl trichloride at 127°·19 is 1·63067; hence its specific volume is $\frac{173{\cdot}73}{1{\cdot}63067} = 106{\cdot}54$.

It is thus evident that the specific volumes of vanadyl and phosphoryl trichlorides are not equal; the compound with the higher molecular weight has the greater specific volume.

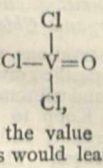
In the communication on the chlorides of phosphorus already referred to, it is shown that if it be assumed, as appears in the highest degree probable, that there is a relation between the manner in which the oxygen atoms in a compound are held in union and their specific volume, it follows that the oxygen atom in $POCl_3$ possesses the smaller of the two values 12·2 and 7·8 assigned by Kopp to oxygen, and accordingly that this atom is attached to the phosphorus by only one combining unit.

Thus—



showing that the phosphorus atom in phosphoryl trichloride possesses the same atomic value as in phosphorus trichloride.

As the difference between the two values for the volume of oxygen, viz., 12·2 − 7·8 = 4·4, is but little less than between the specific volumes of $VOCl_3$ and $POCl_3$, viz., 106·54 − 101·58 = 4·96, it is possible that the difference in the specific volumes of the two liquids may be due to the different manner in which the oxygen atoms are united to the vanadium and phosphorus atoms; for, if V be regarded as a pentad, $VOCl_3$ must be written—



the oxygen atom having the value 12·2. Assuming Kopp's value for Cl, viz. 22·8, this would leave for P and V nearly the same specific volume, viz. :—

P	25·4
V	25·9

From the uncertainty respecting the particular volume to be assigned to the oxygen atom in vanadyl trichloride, our knowledge of the specific volumes of $VOCl_3$ and $POCl_3$ gives us little aid towards solving the question whether the several members of a family of elements have identical specific volumes.

With a view to obtain further evidence, the author has redetermined with special care the boiling-points, specific gravities, and rates of expansion of the tetrachlorides of silicon, titanium, and tin.

The atomic weights of Si and Ti and of P and V show about the same gradational difference :—

Si	28·10	P	31·00
Ti	50·00	V	51·35

And, since the tetrachlorides are free from oxygen, the uncertainty arising from the specific volume of that element is eliminated. He has also compared the specific volumes of the trichlorides of phosphorus, arsenic, and antimony, making use of Kopp's determination in the case of the last-named compound. Material is thus obtained for the discussion of the question from analogous derivatives of two well-defined groups of elements, viz. :—

Si	28·10	P	31·00
Ti	50·00	V	51·35
		As	55·15
Sn	118·10	Sn	122·30

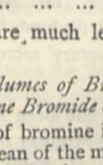
The results of the determinations of the specific volumes of the tetrachloride of silicon, titanium, and tin, liquids of analogous constitution and all derivatives of the tetrad group of elements, serve to establish the conclusion indicated by the difference in the specific volumes of phosphoryl and vanadyl trichlorides, that the specific volumes of the several members of a family of elements are not identical, but that the specific volume increases with the atomic weight of the member.

	Molecular weight.		Specific volume.
$SiCl_4$	169·94	...	121·13
$TiCl_4$	191·84	...	126·03
$SnCl_4$	259·94	...	131·41

It is also noteworthy that the difference between the specific volumes of tin and titanium tetrachlorides is almost the same as the difference between the specific volumes of vanadyl and phosphoryl trichlorides; the difference between the atomic weights of vanadium and phosphorus is nearly the same as that between the atomic weights of titanium and silicon.

	Mol. weight.	Diff.	Spec. vol.	Diff.
$POCl_3$	153·38	20·35	101·58	4·96
$VOCl_3$	173·73		106·54	
$SiCl_4$	169·94	21·9	121·13	4·90
$TiCl_4$	191·84		126·03	

It would seem from this that the constitution of vanadyl trichloride is similar to that of the phosphoryl compound, and must therefore be expressed by the formula—



in which V appears as a triad, the oxygen atom having the same specific volume as in phosphoryl trichloride. On the other hand, the order of the divergences shown by P, As, and Sb (*vide infra*), would appear to indicate that V may be pentad in this compound, whence O would have the volume 12·2.

The numbers representing the specific volumes of the trichlorides of phosphorus, arsenic, and antimony exhibit a gradational order similar to that shown by the volumes of the tetrachlorides of silicon, titanium, and tin, and also by the specific volumes of phosphoryl and vanadyl trichlorides :—

	Mol. weight.	Spec. vol.
PCl_3	137·38	93·54
$AsCl_3$	181·53	94·64
$SbCl_3$	228·68	97·82

although the differences are much less than in the cases of the two latter groups.

III. *On the Specific Volumes of Bromine and Iodine Monochloride; and of Ethene Bromide and Ethene Chloriodide.*

The molecular weight of bromine is, as is well known, nearly equal to the arithmetic mean of the molecular weights of chlorine and iodine: hence the molecular weights of bromine and of iodine monochloride (ICl) are nearly identical. These substances closely resemble each other in physical properties. Both are dark-red liquids about three times heavier than water. Bromine boils at about 59°·5, and solidifies at −24°·5; iodine monochloride melts at +24°·5, and boils at 101°: the interval between the boiling- and melting-points is therefore approximately equal.

It appeared to the author of interest to determine (1) if the specific volumes of these liquids exhibit a relation similar to that which is shown by their molecular weights; and (2) if the relation in their specific volumes is preserved in analogous combinations of the two bodies. He has accordingly determined the specific gravities, boiling-points, and rates of expansion of bromine and iodine monochloride, and of the compounds which these substances form by their union with ethene, C_2H_4. The observations also serve to determine if bromine and iodine monochloride preserve, when in combination, the volumes which they possess in the free state.

It is evident from the observations that the specific volumes of bromine and iodine chloride are not equal, neither are the specific volumes of ethene bromide and ethene chloriodide; the bodies with the greater molecular weights have the greater specific volumes.

	Molecular weight.	Specific volume.
Bromine	159·90	53·62
Iodine chloride	162·31	56·32
Ethene bromide	187·90	97·30
Ethene chloriodide... ...	190·31	101·27

The number obtained for iodine monochloride differs considerably from the volume calculated by means of Kopp's values (Cl = 22·8, I = 37·5), viz., 60·3. The specific volume of bromine (Br_2) is also less than Kopp's number, 55·6. The value assigned to chlorine is unquestionably far more accurate than that given to iodine, since the value of the latter element was calculated from only two or three compounds, whereas the former number was deduced from a comparatively large number of chlorinated products. That the value for iodine needs revision seems to be confirmed by Billet's observations of the specific gravities of liquid iodine at various temperatures. If his results be plotted down and the curve prolonged to the boiling-point of iodine, we find that the specific gravity of iodine at this point is 3·780; hence the specific volume of iodine (I.)—

$$= \frac{126·85}{3·780} = 33·5.$$

If now this value be added to that of chlorine as given by Kopp, we get a result identical with the observed volume of iodine monochloride—

$$33·5 + 22·8 = 56·3.$$

If we subtract the specific volumes of C_2H_4, as calculated by the aid of Kopp's values (C = 11, H = 5·5, C_2H_4 = 44), from the specific volumes of ethene bromide and ethene chloriodide, we obtain numbers which are nearly equal to the specific volumes of bromine and iodine chloride respectively—

$$97·30 - 44 = 53·30.$$
$$101·27 - 44 = 57·27.$$

This correspondence between the two sets of values seems to warrant the conclusion that bromine and iodine chloride possess the same volume in a compound which they have when in the free state.

It is not unreasonable to suppose that the same may be true of ethene itself, viz., that at its boiling-point it would possess the same volume which it has in the bromide and chloriodide at their respective boiling-points. On this assumption the specific gravity of liquid ethene would be—

Calculated from $C_2H_4Br_2$	0·641
,, ,, C_2H_4ICl	0·624

Chemical Society, March 2.—Prof. Abel, F.R.S., president, in the chair.—This meeting was entirely occupied with the discussion of the various points in connection with water analyses, raised by Dr. Frankland's lecture at the previous meeting. The debate, which lasted until a late hour, turned chiefly on the respective merits of Frankland and Armstrong's "combustion method," and of the "albumenoid ammonia process" of Wanklyn, Chapman, and Smith, for determining the amount of impurity in potable waters.

Mathematical Society, March 9.—Wm. Spottiswoode, F.R.S., vice-president, in the chair.—Messrs. Cockshott and R. T. Wright were elected members, and Messrs. Elliott, Leudesdorf, and Russell admitted into the Society.—Prof. Cayley made communications on the bicursal sextic and on the problem of three-bar motion. The discovery by Mr. Samuel Roberts of the triple generation of a three-bar curve throws a new light on the whole theory, and is a copious source of further developments. Prof. Cayley gives in its most simple form the theorem of the triple generation; he also establishes the relation between the nodes and the foci, and further gives other researches. The two papers are intimately related to one another.—Prof. Clifford spoke on the classification of geometric algebras. He sketched out what had been done by Argand (1806); Möbius (1827); Peacock and the Cambridge School (1834); Hamilton (1843); Grässmann (1844, 1862); Peirce (1870); and mentioned results he has himself obtained, for some of which he had not yet got satisfactory explanations.

Zoological Society, March 7.—Dr. A. Günther, F.R.S., vice-president, in the chair.—Dr. Günther exhibited and made remarks on specimens of a minute Australian mammal (*Antechinus minutissimus*) and of a species of *Palythoa* parasitic on a Mediterranean sponge.—Prof. Garrod read a paper on the anatomy of the Courlan (*Aramus scolopaceus*), which he regarded as showing in many respects a close affinity to the Cranes (*Grus*).—A communication was read from Mr. T. E. Buckley, containing remarks on the past and present geographical distribution of the larger mammals of South Africa.—Dr. Cobbold, F.R.S., read the fourth of his series of notes on Entozoa.—Sir Victor Brooke, Bart., read some supplementary remarks on the newly discovered Persian Deer (*Cervus mesopotamicus*), based on additional specimens and information received from Mr. Robertson, H.B.M. Vice-Consul at Busreh.—A second communication from Sir Victor Brooke contained further observations on Schomburgk's Deer (*Cervus schomburgki*) of Siam.

Royal Microscopical Society, March 1.—Mr. H. C. Sorby, F.R.S., president, in the chair.—A paper was read by Mr. W. Hartley, F.C.S., descriptive of certain observations and experiments on the fluids contained in quartz cavities, and which appeared to be liquid carbonic acid, mixed in most cases with water. The subject was illustrated by drawings and by specimens, and experimental demonstrations under the microscope.—A paper was also read by Mr. F. Rutley on the structure of certain rocks, Obsidian and Leucite, and on the spheroidal structure observed in the perlites. The subject was freely illustrated by diagrams and specimens exhibited in the room. A paper by the Rev. W. H. Dallinger, on a new arrangement for illuminating and centering for high powers, was taken as read, it being understood that though of great interest it could not readily be explained without the numerous illustrations by which it was accompanied.

Institution of Civil Engineers, Feb. 22.—Mr. G. R. Stephenson, president, in the chair. The paper read was on the Probable Errors of Levelling, with Rules for the Treatment of Accumulated Errors," by Mr. Wilfred Airy, B.A.

Feb. 29.—Mr. Geo. Robt. Stephenson, president, in the chair.—The first paper read was on the floods in England and Wales during 1875, and on water economy, by Mr. George James Symons, secretary to the Meteorological Society.—The second paper read was on evaporation and on percolation, by Mr. Charles Greaves.

Victoria (Philosophical) Institute, March 6.—A paper on the Horus myth in its relation to Christianity, was read by Mr. W. R. Cooper, F.R.A.S.

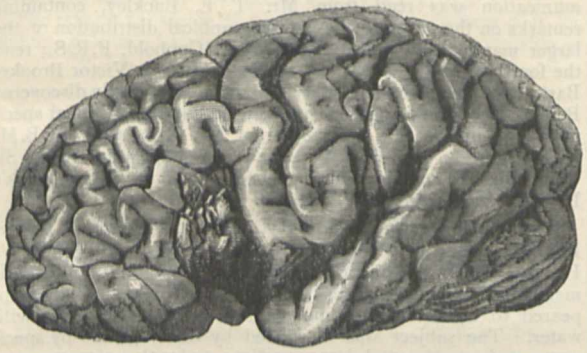
MANCHESTER

Literary and Philosophical Society, Dec. 6, 1875.—Mr. C. Bailey, vice-president, in the chair.—Mr. Sidebotham, F.R.A.S., sent for exhibition some sand from a river far inland of New Guinea, containing particles of gold, magnetic and non-magnetic iron, foraminiferæ, silicified fragments of echini, and shells.—Mr. J. Cosmo Melvill exhibited two specimens of the Spurge Hawk Moth (*Deilephila euphorbiæ*), said to have been captured in the larval state at Ecclesbourne, near Hastings, feeding in all probability on *Euphorbia amygdaloides*, as he subsequently visited the spot and could see no trace of any other Spurge.

Jan. 17.—Mr. John Barrow in the chair.—Mr. Sidebotham, F.R.A.S., exhibited a magnified drawing and specimens of *Lymexylon navale* from Dunham Park, and read a short paper on the life history of the insect, which he and Mr. Chappell had studied since its discovery in Dunham Park in 1872. Mr. Sidebotham also read a paper on *Psammodius sulcicollis*, and exhibited specimens taken at Southport in 1875.—Mr. Plant exhibited various objects of interest, including a Longicorn Beetle (*Astinomus ædilis*) from a coal mine near Manchester; also cases of a North American Caddis Worm (*Phryganea* sp.) much resembling a mollusc of the genus Valvata, and once named by Lea *Valvata arenicola*.

GENEVA

Physical and Natural History Society, Jan. 20.—Dr. Prevost, Head Physician to the Geneva Cantonal Hospital, presented a photograph of the brain of a person who had been affected with aphasia. The lesion, which consists in a slightly yellowish softening somewhat like cicatrisation, occupies a space of about two centimètres on the posterior part of the third left frontal convolution. The meninges are adherent on a level with the diseased point. The "island" of Reil is healthy except at a point which touches the affected convolution. The interval separating two convolutions of the "island" presents a yellowish coloration, and contains granulous bodies. The convolutions themselves of the "island" are, on the other hand, sound. This brain belonged to a woman aged seventy-five years, affected for about a month with right hemiplegia without contractions and without loss of sensibility, and who presented an almost



complete aphasia. Incapable of speaking, she pronounced only isolated syllables without any meaning, as *Eh, eh :* Ah, oi ; - - - eh, *baba* - ah ! *ba, ba, za-za-ya.* One day she said *maman ;* this was the only comprehensible word she uttered. She succumbed twelve days after entry, to bronchitis, for which she came to the hospital. The lesion observed in this case is that which M. Broca regards as constant in cases of aphasia. It is known that M. Meynert and others, on the contrary, localise the faculty of speech in the lobule of the insula, which in the above case was scarcely touched. Dr. Prevost observed at the Cantonal Hospital another case of aphasia, in which the lobule of the insula was the seat of the lesion, while the third left frontal convolution was intact, and thinks we cannot localise exactly the faculty of language exclusively in either of the seats in question.

PARIS

Academy of Sciences, March 6.—Vice-Admiral Paris in the chair. The following papers were read :—Note on geodesic operations undertaken in Brazil, by General Morin. A Commission is to determine the position of a series of stations from Rio de Janeiro to the town of San Juan de Rio Claro, and the mouth of the Tiele in the Parana. There will be measured an arc of parallel of about 23° S. lat. and 9° to 10° in longitude ; and an arc of meridian from about 2° N. lat. to about 33½° S. lat. or more than 35½°.—Transformation of nautical astronomy through the progress of chronometry, by M. Yvon Villarceau.—Note on the steam jacketing of engine-cylinders, by M. Resal.—On the periodical variations or inequalities of temperature, by M. Sainte Claire-Deville. From further data he is able to show that the oscillation of the half of Nov. 1873 was perceptible over Europe, Asia, and America and the northern part of Africa ; that is, over nearly the whole northern hemisphere. A similar oscillation in November, 1874, seems to be established.—On a new simplification of the fundamental law of electrodynamics, by M. Clausius.—The Academy nominated candidates for the vacant chairs of zoology and mineralogy ; MM. Alph. Milne-Edwards and Oustalet, for the former, MM. Descloizeaux and Janettaz for the latter.—On the absorption of bicarbonates by plants in natural waters, by M. Barthélémy. *Inter alia*, these bicarbonates do not serve the respiratory action, for the quantity absorbed is not in proportion to the rapidity of vegetation. During night, and in water equally saturated, the plants seem to excrete a part of the bicarbonates absorbed by day.—M. Dupuy de Lôme presented a memoir, by M. Bertin, on the rolling of ships.—M. Andrade described a new governor for steam-engines.—M. de Rostaing spoke of the antiseptic properties of the root of madder. A piece of meat had been kept from July, 1875, to February 1876, in a pot containing the root in powder form, and which had frequently been opened. The weight was reduced from 119 to 25 grammes. There was no odour nor development of live organisms.—Methods of transformation based on conservation of an invariable relation between derivatives of the same order, by M. Haton de la Goupillière.—Geometrical demonstration of a relation due to M. Laguerre, by M. Mannheim.—On the photometry of stars, and the transparence of the air, by M. Trepied. The author tabulates the intensities calculated for various stars.—Analysis of the white smoke of a blast furnace in the neighbourhood of Longwy, by M. Gruner.—Action of electrolytic oxygen on glycerine, by M. Renard. The glycerine diluted with two-thirds of its volume of acidulated water, is submitted to the electrodes from six Bunsen elements ; after forty-eight hours the liquor is saturated with carbonate of lime, filtered, and distilled, giving a dilute solution of glyceric aldehyde. The white residue, after evaporation, has for formula $C_3H_6O_3$; M. Renard describes its properties.—Note on the calorific action of certain regions of the brain (vaso-motor apparatuses situated on the hemispheric surface), by MM. Eulenberg and Lander. These experiments were on young dogs, which were submitted to chloroform and curare, and the brain-surface burnt with hot copper wire and stimulated with induction currents. As thermo-electric elements, Dutrochet needles were inserted under the skin of the paws, and were connected with a very delicate galvanometer. The authors define the efficacious calorific region, and the relation of its parts, and they explain the results by vaso-motor apparatuses there which are probably connected with vaso-motor fibres in the peduncle of the brain.—On the action of biliary salts on the pulse, the tension, the respiration, and the temperature, by MM. Feltz and Ritter. It is shown that by injections of natural bile into the blood, in proportions that are not toxical, the pulse is diminished in frequency, the respiration is retarded, and the temperature and arterial tension are lowered.—Some remarks on MM. Feltz and Ritter's note, by M. Bouillaud.—On the *rôle* of the arterial bulb in fishes, by M. Carlet. *En resumé* (1) the bulb preserves the branchial arterioles from the shocks communicated by the heart ; (2) it facilitates the action of the heart ; (3) if its action be prevented, there immediately follows a considerable disorder of the hæmatosis.—Note on inverted sugar, by M. Maumené.

BOOKS RECEIVED

BRITISH.—Evolution of the Human Race from Apes : T. W. Jones, F.R.S. (Smith, Elder and Co.)—Scientific Culture : Josiah P. Cooke, jun. (H. S. King and Co.)—Memoirs of Caroline Herschel : Mrs. John Herschel (John Murray).—The Geological Record for 1874 : William Whitaker, F.G.S. (Taylor and Francis).—Medicinal Plants. Part V. : Bentley and Trimen (Churchill).—Australian Heroes : Charles H. Eden (S.P.C.K.)

CONTENTS