for a more searching and exact investigation of their atomic masses, *e.g.* elements such as tellurium, which occupies a position in the periodic system not in harmony with its atomic mass, and cobalt, which plainly occupies the intermediate position between iron and nickel, and therefore should be intermediate in atomic mass.

In a number of cases the accepted value is based on the investigation of but a single interchange, the value for iron, for instance, being practically based on the results obtained on converting the metal into ferric oxide, and *vice-versâ*; and the relation of hydrogen to oxygen having been established by the reduction of cupric oxide. It is desirable that in such cases other and independent methods should be resorted to, *e.g.* that oxides of a number of metals other than copper should be reduced, with the object of detecting possible constant errors.

It is eminently desirable that an attempt be made to directly determine the ratio of hydrogen to each of the halogens without in any way bringing in the atomic mass of oxygen. Prof. Mallet suggests various methods deserving of study. Also it is very important that the metals of the yttrium and didymium groups should be further investigated. Prof. Mallet rightly terms the yttrium group the opprobrium of inorganic chemistry.

Nearly all that has been written hitherto in regard to the periodic relationship among the elements has involved the use of roughly approximate values only; but it is time that the foundation be laid for a more minute and critical study of the periodic system of classification. Anomalies in the classification as we now find it in our books, glimpses of more detailed relations than as yet clearly appear, tantalizing suggestiveness in so much of what is already before us, call for more precise determinations of the numbers we would discuss before we allow premature discussion to drift into mere fanciful speculation.

In regard to the methods which it is desirable shall be pursued in the determination of atomic masses, Prof. Mallet has much to say. He discusses the selection of processes, the purity of materials, the very numerous directions in which vigilance must be exercised in order to avoid extraneous or accidental causes of error, the quantities of material to be used, the practical precautions to be observed so as to secure accuracy of manipulation and in weighing and measuring, the mode of stating and calculating results, finally calling attention to the advantage to be derived from the application of greater working force and ampler means than can be commanded by private individuals to the determination of atomic masses; with reference to this last point, during the discussion on the paper, the opinion was freely expressed that it was undesirable that such work should be carried out in organized public or semi-public laboratories. The question is, no doubt, a difficult one to settle—such work demands a special temperament combined with genius of a high order and an infinite capacity for taking pains, qualities which must rarely occur united in a single individual. Moreover, in order that the value of a result may be appraised, it is essential to overlook every detail involved in the determination. Given the man, however, there can be no longer a doubt that every possible assistance he may require should be afforded him. It is marvellous that men like Berzelius and Stas, working all but alone and unaided, should have achieved results of such magnitude and universal importance—the moral effect of their example is certainly not less important than are the actual results of their labour.

The last section of Prof. Mallet's paper is devoted to the discussion of the form in which it is desirable finally to state the results. He here advocates the uniform substitution of the expression "atomic mass" for "atomic weight," on the ground that precision in language conduces to precision in thought—an aphorism far too commonly disregarded by chemists. We have now clear conceptions of atoms having constant mass for the same element, of determinable difference of mass in the case of different elements, the several masses and numbers of which regulate the composition of all known substances and the products resulting from interaction among them. The atomic theory has advanced far beyond the condition of a mere working hypothesis on which chemists long stood with more or less uncertain feet; but even if this were not so, considering it, to use a common metaphor, only as a scaffold, there is no good reason, so long as we stand on it and work from it, that we should be careless about tying our scaffold-poles and nailing our planks.

Lastly, Prof. Mallet urges that all atomic masses shall be expressed in terms of the mass of the hydrogen atom taken as unity, objecting strongly to the change to O = 16 which several writers have recently advocated, the most objectionable argument put forward in favour of such change being, he thinks, that the numbers we use are expressive of *ratios* only—that any figures are allowable which correctly express combining ratios, and that there are no reasons for using one set of figures rather than another save mere arithmetical convenience. This involves a grave error, as in adopting as unity the mass of a single atom of any particular element, preferably that one of which the mass is the smallest, we have reason to believe that we express the mass of all the others in terms of this as a really existent, definite, and constant quantity of matter. It is, indeed, difficult to understand when the scientific necessity in so many cases of taking hydrogen as the unit is realized, how the change to O = 16 can be advocated except on the simple utilitarian plea that it is to the analyst's convenience.

Prof. Mallet's monograph is undoubtedly a most admirable exposition of the philosophical lessons to be learnt from the contemplation of Stas's labours.

EXTINCT MONSTERS.[1]

THE volume with this title treats of large animals. It is clearly and simply written, without any pretence at being scientific, and is an excellent book for boys and unlearned people who are curious to be informed upon the subject of fossil animals. It would have escaped criticism altogether but for emphatic words of praise in the preface, and one or two passages in which the author, with second-hand information, speaks authoritatively of predecessors who restored extinct types of life with the slender materials which were available forty years ago. The attraction of the volume and its novelty is a series of restorations of saurians and mammals drawn chiefly by Mr. Smit. These for the most part are based upon the restorations of skeletons made by Prof. Marsh, whose discoveries have inspired Mr. Smit's pencil as much as they have influenced the author's pen. There is not much anatomy beneath the skins of the "Monsters," and they have an aspect as though cotton-wool had taken the place of muscle, or as though the drawings were models for the "Lowther Arcade." This, however, is of less importance than the answer given to the question, Are they reasonably faithful to nature? It does not seem to me that they can claim this merit; they are only reasonably faithful to Marsh. Prof. Marsh draws an animal so as to give one type the maximum height to which the bones can be hoisted; while another is given the maximum length to which the remains can be extended. My own studies would not have led me to reconstruct one of the extinct reptiles upon the lines which are adopted in

[1] "Extinct Monsters." A popular account of some of the larger forms of ancient animal life. By Rev. H. N. Hutchinson, B.A., F.G.S., with illustrations by J. Smit and others. (London: Chapman and Hall, Ld., 1892.)

these restorations. As an example of how a restoration should not be made, we may instance the figure of *Stegosaurus ungulatus* (p. 104), in which the management of the limbs is out of harmony with the evidences of the muscular structure of the tail, and the supra-vertebral crest. The restoration of the Scelidosaurus from the Lias of England is unsatisfactory. There is no better ground for giving a kangaroo-like position to that animal than there would be for drawing Teleosaurus in the same position. The mobility of the neck as drawn is astonishing.

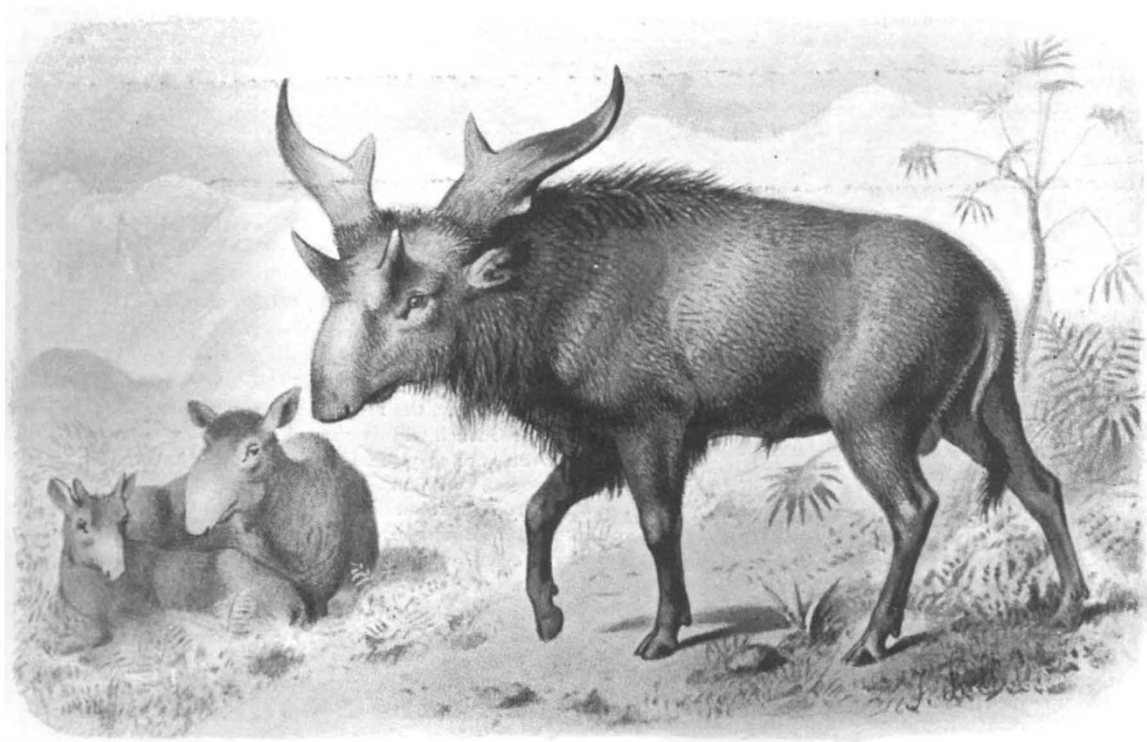
The restorations of mammals are happier. The subjects diverge less from existing types. And probably the most successful in the volume is the spirited restoration of *Sivatherium giganteum* from the Sivalic Hills, though the Glyptodon and Irish Deer are meritorious.

In the text the author is generally content with telling the story of the history of science; but he sometimes strays into less safe matter. Thus an account is given of the eye of the Ichthyosaurus. And it is urged that the bony plates exercised a pressure on the eyeball, so as to make the eye more convex, and improve the definition of near objects. The study of sclerotic defences does not support this interpretation; and in at least one generic division of the Ichthyosauria the sclerotic plates do not overlap at all, but join each other by their lateral sutural margins.

It is perhaps unfortunate that the author gives currency to nomenclature and classification of the terrestrial types of saurians which may not always prevail. If the genera with a bird-like type of pelvis are terrestrial representatives of birds, and the genera with a reptilian type of pelvis are terrestrial wingless representatives of Pterodactyls, then it may not be an advantage to have the Dinosaurs treated as a homogeneous group, or the divisions adopted by Prof. Marsh, or in the British Museum (Natural History), handed on to the unlearned as representing the best available classification. On page 75, the author introduces a restored skeleton of Megalosaurus, which is attributed to Prof. Marsh. The skeleton certainly is not referable to Megalosaurus, which never has the pubic bones or the ilium constructed as in the figure. The restoration has been previously used in Nicholson and Lydekker's "Palæontology," and in Dr. Woodward's "Handbook to the Geological Department of the British Museum," but we do not remember any published authorization for the use of Prof. Marsh's name as authority for confounding Megalosaurus with the allied American type.

Another example of the same kind of interpretation occurs in dealing with Stegosaurus. It is said to have been proved that bones to which the name Omosaurus has been applied really belong to Stegosaurus, and that an unnecessary name has been disposed of. The ground on which this determination is made, not being stated need not concern us now; but it is undesirable that a popular work, whose main merit is that it does not pretend to teach the facts of science, should appear to enunciate judgments on scientific problems. Having described the immense enlargement of the spinal cord in the sacral region of Stegosaurus, the author remarks:—"So this anomalous monster had two sets of brains—one in its skull, and the other in the region of its haunches!—and the latter in directing the movements of the huge hind limbs and tail did a large part of the work." Remarks of this character are sure to be misunderstood, are out of place and incorrect.

The author has read much, and shown an excellent capacity for quotation, but has not always succeeded in using the newest results. He has conscientiously endeavoured to tell the story which is contained in his quotations, but beyond this he does not pretend, except



The four-horned extinct Mammal *Sivatherium giganteum*. The animal on the left is Heladotherium.

in the occasional use of supposed scientific principles as a means of accounting for facts of animal structure. He has dealt with a subject of great difficulty with commendable clearness, and will interest readers who would be unable to follow a more technical exposition of extinct types of life. H. G. S.

ENERGY AND VISION.

THE interesting researches of Prof. S. P. Langley on energy and vision have recently been published in the Memoirs of the American National Academy of Sciences. From this we gather that he was led to investigate the question by the fact that it was not generally recognized how totally different effects may be produced by the same amount of energy in different parts of the spectrum. Two series of experiments were necessary, the first to determine the amount of energy in each ray, the second to observe the corresponding visual effect. The energy was determined as heat by the use of the bolometer, the heat dispersed by a prism being very nearly proportionate to the energy.

In the second series of experiments a beam of sunlight from a siderostat passes through a small hole in a darkened room and falls on a slit with a standard width of 0·1 mm. It is then received on a collimating lens of 11·9 centimetres aperture and 755 centimetres focal length, after which it passes through a prism of about 60° refracting angle. The spectrum thus formed is reflected and brought to a focus on a second slit of one millimetre aperture by a concave mirror, any particular colour being adjusted on the slit by a rotation of the prism. This second slit is screened from all possible stray light by a dark curtain, and is used as a source of illumination for a series of numbers from a table of logarithms, which is attached to a sliding screen. The greatest distance from the slit at which the figures could be distinctly read was then determined, and the law of inverse squares applied. For the brighter colours of the spectrum, the light entering the first slit was reduced by an adjustable photometer wheel.

Actinometric measures were made during the progress of the photometric observations, and showed a solar radiation of 1·5 calories per square centimetre per minute; this naturally being an essential unit.

The energy necessary to give the bare impression of luminosity in different parts of the spectrum, expressed in terms of horse-power, was found to be roughly as follows, the *minimum visibile* being defined as the feeblest light which is observed to vanish and reappear when silently occulted and restored without the knowledge of the observer:—

		Horse-power.
Violet (λ 400)	...	0·000000 000000 00018000
Green (λ 550)	...	0·000000 000000 00000075
Scarlet (λ 650)	...	0·000000 000000 00017000
Crimson (λ 750)	...	0·000000 000000 34000000

These values were derived from observations made by a single observer, Mr. F. W. Very, and are, of course, subject to a large percentage of error.

The general results of the investigation may be best summarized in Prof. Langley's own words:—

"The time required for the distinct perception of an excessively faint light is about one-half second. A relatively very long time is, however, needed for the recovery of sensitiveness after exposure to a bright light, and the time demanded for this restoration of complete visual power appears to be greatest when the light to be perceived is of a violet colour. The amount of energy required to make us *see* varies enormously according to the colour of the light in question. It varies considerably between eyes which may ordinarily be called normal ones, but an average from those of four persons gives the following proportionate result for seven points in the normal spectrum, whose wave-lengths correspond approximately with those of the ordinary colour divisions, where unity is the amount of energy required to make us see light in the extreme red of the spectrum near A, and where the six preceding wave-lengths given correspond approximately to the six colours, violet, blue, green, yellow, orange, red.

Colour	Violet	Blue	Green	Yellow	Orange	Red	Crimson
Wave length	400	470	530	580	600	650	750
Luminosity	1600	62,000	100,000	28,000	14,000	1200	1

It appears from this that the same amount of energy may produce at least 100,000 times the visual effect in one colour of the spectrum that it does in another.

If now it be inquired what the actual value of unity is in ordinary measure, we are able to give this also with a fair approximation, and to say that the *vis-viva* of the waves whose length is 7500 (tenth metres) being arrested by the ordinary retina, represents work done in giving rise to the sensation of the deepest red light of about 0·001 of an erg in one-half second.

NOTES.

THE Prince of Wales has consented to become Chairman of the Committee for the memorial of the late Sir Richard Owen, and to preside at a meeting to further the object, which will be held in the rooms of the Royal Society, Burlington House, on Saturday, the 21st inst., at half-past eleven o'clock. Admission will be by tickets, which may be obtained from Mr. Percy Sladen, Linnean Society, Burlington House, W. (who is acting as secretary to the Committee), or from Mr. H. Rix, assistant secretary of the Royal Society.

THE annual general meeting of the Royal Meteorological Society will be held at 25, Gre at George-street, Westminster, on Wednesday, the 18th instant, at 7.15 p.m., when the Report of the Council will be read, the election of officers and council for the ensuing year will take place, and the President (Dr. C. Theodore Williams) will deliver an address on "The High Altitudes of Colorado and their Climates," which will be illustrated by a number of lantern slides. This meeting will be preceded by an ordinary meeting, which will begin at 7 p.m.

THE general meeting of the Association for the Improvement of Geometrical Teaching is to be held at University College, Gower Street, W.C., on Saturday, January 14, the Rev. C. Taylor in the chair. At the morning sitting (11 a.m.) the report of the Council will be read, the new officers will be elected, and several candidates will be proposed for election as members of the Association. After the conclusion of the formal business Mrs. Bryant will give "A Model Lesson on Geometry, as a Basis for Discussion." After an adjournment for luncheon at 1 p.m. members will re-assemble (2 p.m.) to hear papers by Mr. G. Heppel on "The Use of History in Teaching Mathematics," and Mr. F. E. Marshall on "The Teaching of Elementary Arithmetic." Members who wish to have any special matter brought forward at the general meeting, but who are unable to attend, are requested to communicate with one of the Honorary Secretaries. All interested in the objects of the Association are invited to attend.

DR. LUDWIG BECKER has been appointed to the chair of astronomy at the University of Glasgow.

THE Comet Medal of the Astronomical Society of the Pacific Coast has been awarded to Mr. Edwin Holmes, of London, for his discovery of a new comet on November 6.

ON Tuesday next (January 17) Prof. Victor Horsley, F.R.S., will begin a course of ten lectures, at the Royal Institution, on "The Functions of the Cerebellum and the Elementary Prin-