

That the two signs for the royal name are not engraved immediately above the cone may have resulted from the space above the king's right arm being too contracted. There is another change in the characters on the king's right side which is noteworthy. It will be seen that both the ideograph of the country and the numerals giving the name are inverted. On the left side of the king the characters were to be read from left to right of the reader, but on the right side they are to be read from right to left. This change is in accordance with the *boustrophedon* manner of writing previously mentioned, but it is a change which seems totally incompatible with the idea of forgery.

(To be continued.)

#### ELEMENTS AND META-ELEMENTS.

THE President of the Chemical Society, in his address at the anniversary meeting, has further developed views which he had already propounded in his address to Section B of the British Association at Birmingham, and in a subsequent Friday evening lecture at the Royal Institution. He would have us believe that the atoms of an element are not all precisely of one absolute pattern; that atomic weights, in fact, are not constants, as generally supposed; but that we must regard each element as a species of which many varieties exist almost infinitely more like unto each other than to the atoms of any other approximating species of element; and that what we term the atomic weight is but a mean value around which the actual weights of the individual atoms of the species range within certain limits. Could we separate atom from atom, we should find them varying in weight within very narrow limits on each side of the mean.

Mr. Crookes supports his arguments by a wealth of illustration culled chiefly from his own unique experience; and, whatever the ultimate intrinsic value to science of his hypothesis, there cannot be a question that the study of the transcendent problem of the nature of the elements will have gained greatly in fascination by its promulgation; that lines on which such study may be carried on will have been indicated; and that he will have lightened the inexpressibly wearisome labours of fractionation by casting around them the poetic play of fancy. The subject is of such importance that it appears desirable to consider the position which chemists may fairly take up, and from which it is permissible to criticize the arguments that have led to the suggestion of the existence of meta-elements.

Apart from the higher interest which Mr. Crookes has now infused into them, his researches on the rare earths will ever excite admiration in all who study them, as models of scientific investigation; and they will afford undying testimony to his determination and patience in search of truth, as well as to the incomparable fertility of resource in experimenting of which he is possessed. Among the individual observations are many of a most suggestive and striking character which, sooner or later, must claim attention; but it cannot be denied that the data are as yet insufficient for their exact interpretation. This is true also of Krüss and Nilson's remarkable observations; indeed, it may be questioned whether their results all admit of the absolute interpretation which they are inclined to put upon them. In the paper in which the omnipresence of samarium is demonstrated, in giving an account of the many anomalies which he encountered in his search for  $x$ —the substance characterized by an orange-coloured band in the phosphorescent spectrum, and which subsequently turned out to be samarium—Mr. Crookes tells us how he came to the conclusion that samaria ( $x$ ), which of itself gave little or no phosphorescent spectrum in the radiant-matter tube,

became immediately endowed with this property by admixture with certain other substances—lime, for example—which substances likewise of themselves had no power of phosphorescing with a discontinuous spectrum. Many substances were found effective; and there was a general resemblance between the spectra, but nearly all of them differed from one another in detail. Mixtures of samaria and yttria gave spectra differing to a very marked extent according to the proportions in which the two substances were present. All who take note of these observations must agree that they are of a most remarkable and significant character: they certainly leave no room for doubt as to the necessity of exercising the utmost caution in inferring the absence or presence of particular substances from spectral appearances and changes. Judging from Mr. Crookes's observations, and from our general knowledge of the rare earths, it would almost appear that they have the power to form double oxides akin to double salts, and the effect on the spectrum produced by associating one oxide with another may be compared with the somewhat similar effect of a solvent on the spectrum of a coloured substance. The part that such double oxides perhaps play appears as yet to have been left out of consideration. It is desirable also to take into account the possible presence of double salts, and of their influence on the spectrum, before deciding as to the bearing of Krüss and Nilson's observations.

Reference is made by the President of the Chemical Society in his address to Carl Auer's investigation of didymium. Now the differences between Auer's neo- and praseodymium—the reputed constituents of didymium—are very marked; but as yet unfortunately we have no information respecting their atomic weights. This is true also of the various reputed constituents of the rare earths studied by Mr. Crookes and Krüss and Nilson. Until such information be forthcoming, the suggestion that what is commonly regarded as the atomic weight of an element is but an average value, therefore, can only serve to direct attention anew to the extreme importance of the most exact and exhaustive study of atomic weights.

What is called yttria, according to Mr. Crookes (Proc. R.S., xl. 506) is a highly complex substance capable of being separated into several simpler substances, each of which gives a phosphorescent spectrum of great simplicity, consisting for the most part of only one line. Now, supposing that the several constituent meta-elements of ordinary yttria be found when isolated to differ almost imperceptibly from each other both in chemical properties and in weight, yet the spectral differences will admittedly be very marked—as marked perhaps as are the differences between elements which exhibit very diverse chemical properties and atomic weights; and it will be illogical to deny to these meta-elements the right to rank as elements proper—as distinct species, not mere varieties.

Why, then, does Mr. Crookes think it inadmissible in the elementary examination to open the doors so wide that the number of admissions will be limited only by the number of applicants? It is because he thinks that the periodic system of classifying the elements offers an insuperable barrier to this course. Undoubtedly, if this were granted, there would be little choice left us; but can it be granted? We think not. The scheme at present accepted is after all but a very imperfect and provisional classification. The successional order of the elements in the horizontal series is indeed determined in all cases in which the atomic weight is known with a sufficient approximation to truth; and in certain cases where the properties are clearly marked it is possible to assign the true position in the order of succession to an element even when the atomic weight is very inexactly ascertained; tellurium is an example, having been placed before iodine long ere its atomic weight was ascertained to be lower and not higher than that of

iodine. But in arranging the elements in vertical series we have often great difficulty in determining which are true homologues: we have no difficulty in grouping the alkali metals, the halogens, or sulphur, selenium and tellurium, but how are we to place copper, silver and gold, for example? Are we justified in regarding them as true homologues, and in inserting them as intermediate terms in the group of the alkali metals? Ought we not rather to look upon them as but pseudo-homologues, and ought we not to place them apart from the alkali metals, and apart even from each other in vertical succession? This would lead us, instead of classifying the elements in linear vertical series, to arrange them in pyramidal groups, of which the elements of lowest weight form the summits. In fact, there is no justification whatever for the conclusion that the elements belong to only eight families; the most illiberal treatment leads us to recognize at least twelve, and there is no reason to accept this as the limit. We can thus foresee the possible existence of a far larger number of elements than is at present known, differing probably from each other to a marked extent both in atomic weight and properties. But even then the limit is not reached. Those who have classified the elements according to the periodic system, after all—consciously or unconsciously—have but followed the practice adopted in classifying carbon compounds; and if we consider the results arrived at by the study of hydrocarbons, and apply the conclusions to the elements, there appears to be no difficulty in finding place for a far larger number of meta-elements than even Krüss and Nilson would require to accommodate their host of new claimants for elemental rank. If we arrange homologous hydrocarbons side by side in the order of molecular weight, a scheme corresponding to that devised for the elements will result; but, if molecular weight only be considered, the existence of isomeric hydrocarbons escapes notice; if, however, isomers are included, each simple vertical group at once assumes a pyramidal form. In like manner, if the possible existence of isomeric elements be granted, the periodic scheme would admit without difficulty of the existence of a still larger number of elements even than was above indicated.

Nickel and cobalt have often been supposed to be isomeric elements. According to the most recent determinations of their atomic weights, however, cobalt has a higher weight (58.74) than nickel (58.56); but this result is discredited by the fact that cobalt is usually placed before nickel in the periodic scheme, and should therefore have the lower weight, unless the two elements are isomeric.

Whether among the meta-elements of the rare earths there are not numerous cases of isomerism, remains for the future to determine. Unless, however, some new mode of discriminating other than that involved in determining the atomic weight be introduced, the problem is one which appears beyond our present powers, as experimental error cannot be entirely eliminated. But it is perhaps of all the problems in chemistry the most important to solve, on account of its bearing on the higher problem whether the elements are simple or compound substances. So many converging lines of evidence now render it probable that the elements are compounds that the discovery of isomeric elements would probably suffice to carry conviction to the minds of all who are open to argument on this question. H. E. A.

#### THE DURATION OF LIFE.<sup>1</sup>

JOHANNES MÜLLER, the celebrated German zoologist, said: "All organic beings are transitory; life passes from individual to individual with the appear-

<sup>1</sup> "Ueber die Dauer des Lebens." Von Dr. August Weismann. (Jena, 1882.)

ance of immortality, but the individuals themselves perish." This proposition is perhaps not so true as it seems to be. Nevertheless, it is certainly true that life has its natural limits, at least in all those animals and plants that ordinarily come under the notice of the layman. But the duration of life is very different in different animals, and it would be interesting to know the reason of this. Differences in length of life have been thought to depend on differences in structure and composition. Obviously the size of an animal will fix a certain minimum of time required for growth: owing to the relation between increase of bulk and increase of absorbent surface, pointed out by Leuckhart and Spencer, a larger animal will require a longer time to secure the surplus of nutriment required for reproduction. The degree of structural complication will also fix a minimum time: the activity of the vital processes, the rate of metabolism,—*because it influences the time at which reproductive power, the goal of individual life, is reached*—will influence the total duration of life. But these inner conditions do not fix the duration of life. Birds, whose vital processes are so rapid, may far surpass in age the sluggish Amphibia. Among ants, the males, females, and workers are practically identical in size, complication of structure, or rate of metabolism; yet the females and workers live several years, the males only a few weeks.

We must seek in the environment for the forces finally determining the duration of life. We find the length of life to be in each case an adaptation arranged by natural selection in the interests of the species. So soon as an individual has produced young enough to fill up the gaps caused by death, it ceases to be of use for the species. Where fostering of the brood obtains—be it uterine or post-uterine—we expect and find a longer duration.

The apparently accidental causes of death remove far more individuals than natural death. The longer an individual lives the more chances of accident does it undergo; and so selection, acting in the interests of the species, rather than prolonging the life, hurries on the time of reproduction. At first, it seems impossible that the great age reached by many birds (Raptorial may survive their century) is the shortest possible. But the enemies of the eggs and of the young of birds are very numerous. The death-rate is enormously greater than in the case of mammalian embryos developing within the parent. Adaptation to rapid flight precludes great fertility. Bad fliers like the *Phasianida* lay many more eggs in a season and live through far fewer seasons.

The adaptation is very clear in the case of the larval life of insects. The larvæ of bees and of many ichneumonids placed in the midst of an abundant food supply become pupæ in a few days. The larval stage of predacious larvæ which have to waste time and energy in securing their prey, and of vegetable-feeding larvæ, on account of the less nutritious nature of their food, lasts very much longer. The usually short life of the imago bears no relation to the length or shortness of the larval life, but is directly adapted to its own purposes. In the simplest case, where copulation takes place as soon as the wings are dried, and where the eggs are deposited rapidly and carelessly, the whole adult life lasts but a few hours. Where the mate has to be sought, or the eggs deposited in special conditions, or where active habits preclude simultaneous maturation of eggs, the duration of life is prolonged in correspondence with the special requirements. Adult insects are perhaps the most hunted of animals, and in them is found the extreme case of adaptive shortening.

The inner changes on which natural death depends are not very clear. They can hardly depend on cell destruction; for it is upon that that the processes of life are based. More probably they depend on a failure to produce new generations of cells to replace the cells broken down in the vital processes.

The occurrence of death at all is a provision to secure