REVIEWS.

A Treatise on the Morphology of Crystals: by N. Story-Maskelyne, M.A., F.R.S. (Clarendon Press, Oxford, 1895.)

The publication of Prof. Maskelyne's long anticipated treatise on morphological crystallography marks an era in the history of the science in this country. Hitherto the English student who desired to pursue the subject beyond the mere attainment of a superficial acquaintance has been obliged to have recourse to the admirable treatises in the German and French languages. This, however, is no longer necessary as far as the morphological side of crystallography is concerned, and we now have this fascinating subject most fully treated in our own language, and in an entirely original and delightful manner. The book is constructed upon the plan of the author's Oxford lectures, and those who have not been privileged to enjoy the lectures themselves may now follow the lecturer at their leisure through the wonderful maze of crystalline forms, and develop something of his own enthusiasm as he traces the interesting connection between them.

The basis of the book is eminently mathematical, yet the reasoning is usually sufficiently simple to be incapable of repelling those whose mathematical training has not been of an advanced character, while on occasion sufficiently deep to be a source of satisfaction even to the more mathematically inclined. An admirably lucid explanation of the stereographic representation of crystals is given, accompanied by a sufficient selection of theorems in pure spherical trigonometry to enable a beginner to readily work out any problem in practical crystallography which may present itself. Equally clear and precise are the sections which treat of the fundamental laws of crystal morphology, the rationality of indices, the zone law, and the law of anharmonic ratios, while the Millerian method of notation appears simplicity itself as explained by Prof. Maskelyne. There is, however, one point to which the attention of students about to use the book might with advantage be drawn. It is to some extent unfortunate that the nomenclature of the two lateral axes of a crystal employed by Prof. Maskelyne is the reverse of that adopted by Groth in his invaluable *Zeitschrift für Krystallographie*, and by the whole of the modern German school. Whilst the axis passing from front to back of the crystal is termed the A-axis, corresponding to the Millerian plane (100), in the German scheme, and the axis passing from right to left is lettered B, corresponding to the plane (010), Prof. Maskelyne terms the former the B axis and the latter is designated A. So long as students are fully aware which scheme they are employing, it is of course a matter of no importance, although one cannot but regret that the two systems are not brought into unison, in order on the one hand to avoid confusion in comparing data from German and English sources, and on the other hand in order to save the considerable labour involved in a revision of the facial symbols in translating from one language to the other. For this reason the writer of this review has adopted the German scheme of lettering the lateral axes in all original communications.

Upon the chapters concerning the symmetry of crystals it would be almost impossible to bestow too much praise. The large importance attached to symmetry is indeed a feature of the book, and in carrying it to its logical conclusion Prof. Maskelyne is led to make a most interesting statement, almost prophetic, considering that this portion of the work has been in the press for some time, of the direction in which crystallographical research is now tending. Prof. Maskelyne speaks (p. 171) of crystal symmetry as a geometrical abstraction, which "needs for its development and due explanation a complete science of position applied to the molecular mass-centres, competent to embrace not merely the relative distribution *inter se*—the *intermolecular* distribution—of the chemical molecules constituting the crystallised substance, but also the *intromolecular* arrangement of the atoms, or molecules of secondary order, whereof the molecules of the substance are themselves composed. Then the true significance of the ideal planes and axes of symmetry will be understood, and they will assuredly retain a place in the explanation of crystalline symmetry, since they rise into recognition directly from the fundamental principle of rationality of indices, and are controlled by its consequences." It is somewhat to be regretted that Prof. Maskelyne has not found it convenient to follow up this prescient statement with a *resumé* of the attempts which are being made to-day to ascertain the nature of the molecular mass-centres, and to unravel the mode of distribution within them of the chemical molecules and the atoms of which the latter are composed. A criticism of these researches from his master mind could not fail to be of the greatest use to those who are engaged in attempting to penetrate into this obscure but fundamental region of morphological crystallography. Moreover, we miss in the present volume all allusion to the remarkable mathematical investigations of Sohncke, Fedorow, and Barlow as to the possible modes of distribution in space of the molecular mass-centres. However, Prof. Maskelyne promises us a second volume, and doubtless will introduce into it, along with the consideration of the physical properties of crystals, these most interesting questions relating to their ultimate structure. For what can the morphology of crystals depend upon other than the nature, that is to say the internal structure—and all that this implies as regards the distribution of the matter composing it, the state of motion or equilibrium of the atoms, and the form, store and distribution of energy—of the organised aggregate of chemical molecules which is now currently regarded as the crystallographical unit or crystal-element? It must be that the forces which bind together these crystal units in such perfection of symmetry entirely depend upon the nature of the crystal element as thus defined, and that no comprehensive theory of the ultimate structure of crystals can be arrived at until more knowledge is gained as to the morphology of the crystal element itself.

In the latter portion of the book Prof. Maskelyne gives an admirably practical account of the use of the goniometer, including a full description of Websky's mode of adjusting the instrument. This is followed by a series of carefully chosen examples of crystallographical calculations, and an exceedingly useful account of the current modes of drawing crystals from the ascertained crystallographic elements. It is earnestly to be hoped that Prof. Maskelyne will see his way to complete the further volume in the near future, when he will have made the most important addition to the crystallographical literature of this country since the publication of the fundamental work of Miller. A. E. TUTTON.

An introduction to Chemical Crystallography: by Andreas Fock, Ph.D., translated and edited by W. J. Pope. (Clarendon Press, Oxford, 1895.)

Mr. Pope has rendered a great service to Chemical Crystallography by his translation of the work of Dr. Fock. It is still, unfortunately, a matter of regret that, owing to our totally inadequate methods of secondary education, comparatively few students in this country are enabled to read continental authors in the original, and many who are consequently unable to peruse with advantage the compact little book of Dr. Fock, and the still more recent and comprehensive treatise of Prof. Arzruni of Aachen, will feel indebted to the translator of the former. The relationship between chemical composition and crystalline form is as yet so little understood, that no book on the subject can hope to do more than present a clear idea of the stage to which investigation has reached, and the direction in which it is tending. The opportunities which are afforded to the chemical investigator of studying the crystallographical properties of definitely related substances which he prepares in the course of his synthetical operations, are so numerous that it is greatly to be desired that every student of chemistry who intends to pursue the subject should take up as part of his training a course of practical crystallography. For, as Prof. Maskelyne very truly remarks in a preface with which he introduces Mr. Pope's translation, the crystallographical and physical constants of the new substance are as much a part of its nature as its composition and chemical relationships.

The earlier chapters of the work are devoted to the history of the science, to the modes of formation of crystals, the influence of water of crystallisation upon the geometrical form, and the current views as to the state of the included water. Double salts are next considered in the light of the recent work of Rüdorff, Trevor and Willard Gibbs, and the four conditions of saturation-equilibrium for the pair of simple salts constituting the double salt discussed. Very interesting chapters then follow on the growth of crystals and the nature of crystallites, and a full account is given of the recent explanation of the phenomena by Lehmann on the basis of the variations in the concentration of the environing solution. The most important portion of the book, however, is that which connects crystalline form with chemical composition, and here again very considerable additions to the text have been made by Dr. Fock, and also, with his sanction, by Mr. Pope, in order that the most recent investigations shall be included. The work of Muthmann upon the arsenates and phosphates, and of the writer of this review upon the sulphates and double sulphates containing potassium, rubidium and cæsium, is discussed, and, in short, the translation affords a fairly complete account of the subject up to date. Perhaps one small oversight might be mentioned. On page 104 occur the words: "Although no close relationship can be observed between the indices of refraction of the three salts, yet it will be seen that the refractive indices of rubidium sulphate are intermediate between the corresponding indices of potassium and cæsium." As a matter of fact, they do bear a most interesting relationship, which is fully discussed in the memoir referred to, and is clearly seen when they are graphically represented by curves, and still more clearly when the corresponding optical elasticity relationships are calculated from them and similarly expressed by curves. The change of atomic weight of the metal is indeed most accurately reflected in the optical behaviour of the three salts, and is directly responsible for the beautiful and quite exceptional optical characters of rubidium sulphate.

The nature of physical isomerism, formerly termed dimorphism, affords the subject for another particularly interesting chapter, and although the distinction of Lehmann between physically polymeric and physically metameric substances would appear at present to be of a somewhat superfine character, still it can no longer be doubted that the phenomenon of a single chemical substance crystallising in more than one crystalline form depends essentially upon a different constitution of the crystal-element, the physical molecule, whether the difference is in the number or the arrangement of the chemical molecules of which it is composed. So soon as a satisfactory method is discovered of determining the composition of the physical molecule, we shall be able to to solve this, as well as many other problems of great interest. Indeed, it would seem that such a method is the great desideratum at the present moment, and it will be of distinct service if the translation of Dr. Fock's book calls attention to the fact. The concluding chapters on isogonism and morphotropy afford still further food for thought, and here again it is shown that there is much probability in the supposition of Groth that the crystal-elements of morphotropic substances are of the same magnitude, and that, therefore, the explanation of morphotropy will in all likelihood follow the discovery of a method of determining that magnitude.

The translation of Mr. Pope has a further advantage over the first edition of the original, besides the fact that it is in our own language, inasmuch as many errors, typographical and otherwise, had crept into the German text; these are all corrected, and Mr. Pope has had the additional good fortune to find in Mr. Miers, of the British Museum, an experienced friend to assist him in the revision of the manuscript and proofs.

A. E. TUTTON.

Recherches Minéralogiques of Prof. M. Tolstopiatow. Posthumous edition, pp. xxviii., 186. Moscow, 1893.

M. Tolstopiatow, who was for 30 years Professor of Mineralogy in the University of Moscow, seems to have published comparatively little of his work, but left behind him, at his death in 1890, numerous papers and notes. These, which are somewhat fragmentary in places, have been collected and edited by M. Kriloff to form, together with a biographical notice, the present volume. His favourite subject related to crystallogenesis and the structure of crystals, but a large part of the book is taken up by his observations on the *absorption brushes of epidote*. The latter subject commences with a historical review, in which it is pointed out that some previous observers have confused the true absorption brushes with the idiocyclophanic pictures seen in epidote, and with the interference phenomena due to polarised light from the sky and the polarising action of the crystalline lens of the eye (to which Haidinger's brushes are due). Mention is made of Bertrand's statement that absorption brushes are to be seen in dichroic uniaxial crystals, as well as in biaxial crystals; this, however, is doubted. Instead of cutting plates perpendicular to the two optic axes, the author has preferred to view the unprepared crystals through the faces *c* (001) and *r* ($\bar{1}$01), these being nearly perpendicular to the two optic axes. The same crystal can then be viewed along both axes, with the result that, owing to the twinning of epidote, differences in the two sets of brushes can be seen. The crystals are viewed in ordinary and in polarised light (from the sky or with a nicol), and several beautifully coloured plates are given of the absorption and interference phenomena seen. The "primary" or absorption brushes, which depend on the unequal absorption of the two rays, are disposed in the direction of the orthodiagonal of the crystal (epidote), and do not change their position when a nicol placed in front is rotated, there being only a transposition of the colours. The brushes are often more distinct when viewed through one face than when viewed through the parallel face. The "secondary" or interference brushes (idiocyclophanic), due to an enclosed twin lamina, are of comparatively rare occurrence. It is here supposed that the light is polarised in the crystal, not by the greater absorption of one ray, but by the twin laminæ, with layers of air or of decomposed epidote between, acting as a pile of plates. Notes are also added on the polarisation of the atmosphere, and on the brushes seen in lepidolite and muscovite in natural light.

The second part of the volume, on *the structure of crystals*, is very hypothetical, and commences with the assertion that crystals are not homogeneous, but consist of a nucleus and an envelope, the former being regularly constituted, and the latter irregularly—in fact, a sort of accidental growth. This nucleus, which is called the *cryptopyramid*, and denoted by *kP*, is said to manifest itself, and to be distinguished from the envelope, by differences of colour, dichroism, arrangement of enclosures, cleavage, fracture, and character of the optic pictures (*e.g.* when the nucleus is uniaxial, the envelope is biaxial; variation of the value of 2 E, as in topaz), these being taken to indicate differences in structure of the two parts. This important crystallographic unit, said to be the primitive form (from which the parametral ratios are calculated in terms of the number of molecules along the axes), can sometimes actually be seen in the interior of a crystal as an acute elongated pyramid, singly (in this case taken to indicate hemimorphism, *e.g.* calcite) or doubly terminated. Much importance is also attached to complicated systems of striæ seen in the interior of crystals.

There are also notes on hemimorphism, twins, pleochroism, asterism, &c. From the character of the "cryptopyramid" topaz is regarded as hemimorphic. From certain fissures and marks on the faces it is inferred that topaz is twinned, showing both polysynthetic and crossed twins.

L. J. S.