

of the seeds of *Martynia* have been formed, or the delicate tracery of the pappus of *Tragopogon*, the insectivorous glands of *Drosera*, the roots of *Acanthorrhiza* which grow upwards and become a thorny hedge around the young plant, or the profusion of thorns upon the palms of moist tropical forests. Although fraught with difficulties, the Darwinian theory embraces all such cases; while that defended by the author requires a new line of argument in each separate instance.

Prof. Henslow is rich in expedients, and is a fearless theoriser. He regards the opposite or decussate arrangement of leaves as the primitive, because of the position of the cotyledons; the sheathing base of *Monocotyledons* and *Umbellifers* is a mark of degeneracy; the heterophylly of *Juniperus* is caused by a variation in the amount of nutriment at the plant's disposal. He suggests that the enlarged watery, subterranean parts of desert plants may be due to the blistering action of the hot sand, and that the thickened cuticle of plants in dry climates may be formed or aided by a deoxidation of chlorophyll by excessive light. Lastly, he explains the fact, observed by Volkens, that the stomata of desert plants are frequently closed in the day and open at night, by a reversal of the ordinary reactions of the guard cells to turgescence. "Perhaps the arrested moisture, due to the check to transpiration, may cause turgescence by day, which closes the slit, while its cessation at night brings about a relaxation."

We confess that Prof. Henslow's views on geotropism are puzzling and disappointing. He denies the existence of negative geotropism; and bases his argument, curiously enough, upon Knight's well-known wheel experiment. Here he discovers a *centripetal pulling* force which causes the stem apex to grow towards the centre of the rotating wheel, and at the same time a *centrifugal pulling* force which causes the root to grow outwards. "Each end of the plant is therefore subjected to what might be called an accelerating 'pulling' force." A moment's consideration will show that there is no such *centripetal pulling* force acting upon the free stem-apex. Prof. Henslow seems to lose sight of the fact that the action of gravity upon parts of plants is directive rather than purely mechanical.

Further, it is not clear why gravity ceases to act upon the apex of *Ranunculus heterophyllus* because it is immersed in water (p. 201)!

There are many points which will exercise the morphologist. Why are the first leaves of water plants regarded as phyllodes? We hardly agree with Prof. Henslow's ideas on the interchangeability of stems and roots in nature, although each may arise from the other endogenously.

Then again, it is difficult to follow the author's description of the vascular system of water plants on pages 145-7. We gather that he regards "spirals" as the only true "tracheæ"; and "vessels" appear to have quite a different meaning. The following is far from clear: "In aquatics the punctated vessels may closely simulate punctated fibres, the chief differences being in the lessened diameter of the latter, and the more or less oblique position of the septa. Then these pass into thin-walled fibres of the same shape, and finally become 'fibrous cells,' when they may contain starch."

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We have read the volume with great pleasure, both because of the mass of interesting details of plant biology, and the ingenious piecing together of evidence; nevertheless, we do not think that Prof. Henslow's attempts to reconstitute the theory of evolution are altogether successful.

C. A. BARBER.

#### SOLUTION AND ELECTROLYSIS.

*Solution and Electrolysis.* By W. C. Dampier Whetham, M.A. (Cambridge: The University Press, 1895.)

UP till the beginning of the present year the English reader had practically only two text-books to guide him in getting some idea of the scope and importance of the Newer Theory of solutions. These were "Solutions," a translation of certain parts of Ostwald's *Lehrbuch*, and "Outlines of General Chemistry," by the same author. The former gave but an imperfect account of the subject, as it excluded the electrical properties of solutions, and thus the mass of material which groups itself around the hypothesis of electrolytic dissociation; while the latter, although giving a general survey of the theory, dealt with it in but a superficial manner. To these was added, early in the present year, Nernst's "Theoretical Chemistry," and in this book is to be found the best description in English of the present condition of the theory; for although the description is by no means rich in records of actual observations, yet, on account of the neat methods used in dealing with the theory of individual questions, and the comprehensive mode of attacking the entire subject, it is worthy of the attention of all students of physical chemistry.

The book under notice gives a much more detailed survey of the theory as a whole than that found in Ostwald's "Outlines." The mode of treatment is, however, less thorough than that in Ostwald's "Solutions," and has little resemblance to the compact and orderly method used by Nernst.

In his preface the author states that a considerable part of the first six chapters is taken from Ostwald's *Lehrbuch*, and this is unmistakably evident on reading them through. They deal with solubility, the different kinds of solutions, diffusion and osmotic pressure, freezing-points, and vapour-pressures. The remaining five chapters have much greater claims to originality, and are devoted to the electrical properties of solutions—Faraday's laws, polarisation, the theory of the voltaic cell, the migration and velocity of the ions, electric conductivity and its correlation with other properties, and theories of electrolysis.

The student familiar with the elements of physics and chemistry will have little difficulty in following the information supplied. The author has, in particular, to be thanked for setting out at length the more important applications of thermodynamics to solutions, as these are often a source of worry to the beginner. Many indications are also given of attention to points which are often scantily treated, as in the case of the theory of diffusion, the meaning of osmotic pressure, the theory of the voltaic cell, &c. On the other hand, the treatment of solutions in gases, associated solutions, Beckmann's molecular weight apparatus, &c., is extremely superficial. There

are also certain points to which attention must be drawn, in view of future editions of the book.

When dealing with plasmolysis (p. 37), the author omits to state that the animal or vegetable cells used must contain living protoplasm, and the reader is led to infer that artificially-coloured, instead of naturally-coloured cells are employed for plasmolytic observations. Although certain stains are known which are not immediately fatal to living cells, there is no record of their use in plasmolytic experiments. It is also made to appear that red blood corpuscles contain a semi-permeable membrane, despite the conclusive observations of Hamburger to the contrary. In connection with this subject, it is misleading to state (p. 38) that De Vries "established the most important generalisation" that solutions of the same molecular concentration are isotonic, for inasmuch as by far the greater number of his solutions were electrolytic, his results clearly contradict this statement. On p. 34, the credit of preparing semi-permeable membranes is given to Pfeffer, whereas M. Traube first described their preparation and properties. As regards the more general treatment of the first section, it is noteworthy that although the solubility of mixed substances is to some extent discussed, no notice is taken of the work of Roozeboom, and Gibbs' phase-rules, which apply to all cases of heterogeneous equilibrium in solution, are not even mentioned.

In the section on electrolysis, some inkling might have been given of the wide field opened up for the verification of the ionic hypothesis by its application to the operations of analytical chemistry. Among smaller points, it may be noted that, on p. 128, potassium platinichloride should be sodium platinichloride, and in a somewhat vague paragraph, on p. 164, we read that the introduction of oxygen, sulphur, or a halogen, which raises the affinity of a weak acid, "has no effect on the affinity of these strong acids." Since the strong acids quoted by the author are hydrochloric, nitric, &c., the student may be pardoned if he is puzzled to understand how the introduction is to be brought about, or what acids would result if it were possible.

A novel feature in a book of this kind is an attempt made by the author to reconcile the Hydrate Theory with the Newer Theory of solutions. Of course it has all along been apparent that the latter does not preclude combination between solvent and dissolved substance. What the upholders of the newer theory assert, however, is that at the present time there is no definite evidence that, in general, such combination exists. An attempt to reconcile the two views should therefore involve a careful study of the experimental data in favour of combination. It is for this reason unfortunate that the author gives but a very brief statement of the results of the extensive work of Pickering in this field.

As an appendix to the book is given part of the list of the conductivity, migration, and fluidity data of solutions compiled by Fitzpatrick for the British Association Report of 1893. For the sake of chemical readers it is to be regretted that most of Ostwald's observations on the conductivity of organic substances have been omitted, since it is in the case of such substances that the close connection between the electrolytic properties of solutions and the chemical nature of the dissolved substances can be most conveniently traced.

J. W. RODGER.

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# THE THEORY OF ALGEBRAIC FORMS.

*An Introduction to the Algebra of Quantics.* By E. B. Elliott, M.A., F.R.S. Pp. xiv. + 424. (Oxford: Clarendon Press, 1895.)

THE history of the theory of algebraic forms gives a striking example of the fact that the germ of a mathematical doctrine may remain dormant for a long period, and then suddenly develop in a most surprising way. The principles of the calculus of forms are to be found in the arithmetical works of Lagrange, Gauss, and Eisenstein; but the great expansion of the theory, with which we are now so familiar, practically dates from the publication of the papers of Boole, Cayley, and Sylvester, about fifty years ago.

It is well known that the theory of forms has advanced upon two distinct lines: one method being derived mainly from the differential equation of sources, supplemented by generating functions and the theory of equations; the other, from the symbolical representation of a quantic, invented by Aronhold, and applied with such power by Clebsch and Gordan. Until quite lately, the symbolical method might not unjustly claim to be superior in respect of organic unity, as it must still be admitted to be in compactness and geometrical suggestiveness; but the other method has now undergone a remarkable transformation at the hands of Hammond, MacMahon, Hilbert, and others, and has led to results of the highest interest and value, which the symbolical calculus could not easily or naturally supply.

With the exception of three pages, devoted principally to Cayley's hyperdeterminant notation, Prof. Elliott does not refer to the symbolical method. With his reasons for not using it we must reluctantly acquiesce. It is quite true, as he says, that a mere outline of the method would have been worse than useless; and by omitting it altogether, he has been enabled to give a very lucid and thorough account of the subject from one consistent point of view, without that excessive condensation which is so often a defect rather than a merit.

It is not necessary to say much of the earlier chapters, except that, like the rest of the book, they are very clear and pleasant to read; in particular, the proof that every covariant of a covariant is a covariant of the original form is easier to follow than that given by Salmon. It is when we come to chapters vi. and vii., which deal with seminvariants and their annihilators, that the influence of recent discoveries begins to be felt. Thus the notions of *excess* and *extent* are introduced, and the annihilators of invariants and covariants of systems of quantics are indicated.

Chapter viii. discusses generating functions, and is a very good introduction to this part of the subject. It does not profess to be exhaustive; and it is perhaps as well that the author has refrained from giving the detailed reduction of the generating functions for forms higher than the quartic. This would have taken up a good deal of space; and the full discussion for the lower forms, which is given, is quite enough to illustrate the general procedure. The results for the quintic are also stated, and references are given to the memoirs of Sylvester and Franklin, which ought to be easily understood by any one who has mastered this chapter.