THURSDAY, JANUARY 25, 1877

THE ENCYCLOPÆDIA BRITANNICA

Encyclopædia Britannica. Ninth Edition. Vol. V. (Edinburgh : A. and C. Black, 1876.)

THE article of greatest scientific interest in this volume is, of course, that on Chemistry. We can conceive of few literary tasks more trying to a duly qualified and conscientious writer than to attempt to give a comprehensive and well-balanced account of the rise, progress, and present position of a science like chemistry within an encyclopædia article of such compass as even the most compliant of editors would tolerate. And we must confess at the outset that it was with some feeling of sympathy for its authors, engendered by this reflection, that we commenced the examination of their essay—a feeling, however, which quickly altered its complexion as the consciousness grew upon us that in everything which is essential it may fairly compare with any one of its predecessors. And than this, no higher praise, we think, is possible.

The article divides itself, naturally, into three parts. In the first part, which we owe to Mr. F. H. Butler, is traced the origin and growth of chemistry. Its only fault is its exceeding brevity ; it is hardly to be expected that within the space of some six or seven pages we can have a picture as lively or as complete as we find in the works of Hoefer or of Hermann Kopp. Of the birth of chemistry very little is said, and only the slightest reference is made to its association with the Greeks, Arabians, and Egyptians. With the rise of the Spagyrists with Paracelsus, who taught that the true use of chemistry is not to make gold but medicines, we seem to perceive the first attempts at a rational pursuit of the study, but the crooked manner in which the sect sought to advance its doctrine of the threefold constitution of matter was too much for the patience even of the gentle Robert Boyle, who had scant mercy for "the sooty empiricks, having their eyes darkened and their brains troubled with the smoke of their furnaces," who were "wont to endeavour to evince their salt, sulphur, and mercury (to which they gave the canting title of hypostatical principles) to be the true principles of things." The growth of Iatro-Chemistry until its final overthrow by Hoffmann so late as the beginning of the eighteenth century is concisely and carefully worked out, and the relations of its doctrines to those of Becher and Stahl are made apparent. Indeed the largest portion of this section of the article is devoted to the Phlogistic period, and the theory itself is set in a proper light. It has been too much the fashion to decry the services of Stahl's great conception, and people have marvelled that men of insight and logical minds—such men as Bergmann, Macquer, Scheele, or Cavendish—could have been hoodwinked by such a doctrine. But the theory was perfectly consistent in the outset, and it was only by the very excellence with which it served the purpose of a great theory that it fell. We are glad to find, too, that the services of Black and Cavendish as the real founders of quantitative chemistry meet with a just appreciation. The labours of Lavoisier are estimated with equal impartiality. For, as Liebig declares, although "Lavoisier discovered no new body, no new property, no natural phenomenon previously unknown . . . his immortal glory consisted in this—that he infused into the body of the science a new spirit ; but"—he is careful to add—"the members of that body were already in existence and rightly joined together." It may be worth while noting that the date of Lavoisier's famous memoir "On the Nature of the Principle which Combines with the Metals during their Calcination and which Augments their Weight," is given as 1755, at which time if, as some authorities declare, he was born in 1745 (our author says 1743), the great chemist would be of the tender age of ten years ; the careful reader would doubtless marvel at so remarkable an instance of precocity did he not discover from the context that the memoir must be antedated by at least twenty years. That *clarté* which was the distinguishing feature of Lavoisier's mind is reflected in his "Traité de Chimie," with an outline of which Mr. Butler fitly closes his account of this stirring epoch. It is instructive to trace the progress of our knowledge of the elementary bodies from the date of the publication of that work. Excluding light and caloric, Lavoisier recognised some thirty simple substances ; since his time the number of the elements has doubled itself, but it is remarkable to observe how slow, with all our appliances, is the rate of discovery in these degenerate days. Gallium, the latest on the list, was brought to light in 1875. If we divide the lapsed portion of the present century into periods of twenty-five years, we find that the times of discovery distribute themselves as follows :—

1800–1825	22 New elements.
1825–1850	10 ,, ,,
1850–1875	5 ,, ,,

And yet, if we may credit M. Mendelejeff and his Laws of Periodicity, we have nothing like our proper complement of elements. Obviously, therefore, if the present rate of increase is to be maintained, the occupation of the chemist will not be gone for some time to come ; ages must elapse before even the alphabet of his science is constructed ; and by the time that Macaulay's Richard Quongti goes to complete his studies at the University of Tombuctoo, attracted by the high scientific character of Prof. Quashaboo, the learned professor will doubtless be engaged on the article "Chemistry," to occupy an entire volume of the 101st edition of the "Britannica," which will still be published by the eminent firm of Black.

Mr. Butler repeats the common statement, that the atomic theory first suggested itself to Dalton during his investigations on light carburetted hydrogen, and olefiant gas ; the matter is probably of little moment, but as an historical fact it may be noted that the germ of his great work is to be found in his "Experimental Inquiry into the Proportion of the Several Gases Contained in the Atmosphere," read before the Literary and Philosophical Society of Manchester in November, 1802. In this paper Dalton states that one of the component gases—the oxygen—has the power of combining chemically, in two different proportions, with nitric oxide, to form two distinct compounds ; and that the quantities by weight of oxygen which thus combine are in the ratio of one to two. It was this circumstance which first aroused Dalton's attention to the fact that one chemical element can combine with another in two different but definite proportions by weight. The study of the hydrocarbons and of carbon monoxide and dioxide was not taken up until two years later. (See Roscoe's "John Dalton and his Atomic Theory," Science Lectures, 1874.)

It has probably been from considerations of space that Mr. Butler has been unable to do more than glance, in the briefest possible manner, at the progress of modern theory, and we fear that in one or two instances, his reader may complain that in the effort to be concise he has become obscure. The idea of the polyatomicity of the elements is dismissed in a single line. The doctrine of *materia prima* has played such an important part in the past, and if we may judge from the signs of the times, is destined to play a still more important part in the future, that it is surely an omission of some moment to neglect all mention of Prout's hypothesis, of Dumas's extension of it, of its unquestionable influence upon the French school, and of the labours of Stas in connection with it. It is to be regretted too that so little is said of the rise of what may be termed the physical side of chemistry; of, for example, the influence of Dulong and Petit's law, of the law of Avogadro, of Mitscherlich's law of isomorphism, and that no direct reference is made to modern notions of the constitution of matter. It is true that certain of these matters are mentioned in subsequent sections of the general article, but they have their proper place in a historical account of the growth of the science. Lastly, the value of this portion of the article would have been greatly augmented by some reference to the bibliography of chemical history; Mr. Butler will excite the interest and curiosity of many students by his well-written and thoroughly readable sketch; he would have increased their gratitude by informing them how they might satisfy their craving for further knowledge.

The second, and by far the largest, portion of the article (it occupies nearly two-thirds of the whole) treats of Inorganic Chemistry, and is the work of Prof. Armstrong. In its main features it differs considerably from the ordinary run of descriptive treatises, although we question whether any one of them exhibits a more complete *coup d'œil* of the present position of this branch of the science. No space is wasted on mere *technics* (if we may employ a word which is sanctioned by Worcester), and it would be almost impossible for one ignorant of the science to employ it as a *vade mecum*. It is characterised by the manner in which broad and comprehensive principles are grasped and illustrated; entire groups are contrasted or compared, marched up and down as it were, like the skilful handling of battalions. Nevertheless, whilst we cannot but admire the fearless manner of his evolutions, we are afraid that Dr. Armstrong's love and zeal for system and generalisation occasionally allure him upon tender ground. The article is, presumably, not specially written for chemists, although we have no hesitation in affirming that every chemist who reads it will do so with pleasure, and therefore hypotheses such as that Epsom salts may be regarded as the normal magnesium salt of dihydrated sulphuric acid, H_6SO_6, crystallised with five molecules of water; or that the true formula of potassium perchlorate is $K_2Cl_2O_8$; or that the molecule of selenium dioxide is probably not represented by the formula SeO_2; or that the so-called hydrogen disulphide has presumably the composition H_2S_5; which are not the common property of the science, however ingenious and suggestive they may be, as these undoubtedly are, do not, we submit, come within the scope of a treatise which should primarily be a register of facts for the use of general readers. We allow that Dr. Armstrong is generally very cautious in his mode of stating these and similar conjectures, and possibly a very careful reader, whilst admitting their relevancy, would regard them in their proper light of tentative hypotheses; but all readers are not careful; the beaten path, we are told, is the safe path; and although scientific preachers, unlike other preachers, may with impunity be as heterodox as they please among themselves, it may be doubted how far it is expedient to preach any other than perfectly safe doctrine to the laity. This is really the only piece of adverse criticism we have to offer. When facts are known they are stated, and with remarkable perspicacity. As instances of careful and judicious compilation we may refer to the sections on ozone, hydrogen dioxide, and the organo-silicon compounds. A commendable feature is the recognition of the great importance of what we have before termed the physical side of chemistry; and in this respect Dr. Armstrong's treatise is unique: we have no hesitation in asserting that everything of value which recent investigation in the domain of chemical physics has brought to light is carefully interwoven in the proper place. The results of the thermo-chemical work of Thomsen and others; of the work of Troost and Hautefeuille and Brodie on dissociation phenomena; of the researches of Berthelot and others on the state of salts in solution; and of numerous other works scarcely less important, are duly set forth, and in such relation as to enforce their value and applicability. Indeed, in one or two cases we have the results of work which has not yet been fully published, as in the account of the action of nitric acid upon the various metals. It appears that with the exception of silver all the metals give with this acid a mixture, in varying proportions, of free nitrogen and nitrogen dioxide and monoxide. If, however, we compare the behaviour of the acid in the case of the three closely-related metals, magnesium, zinc, and cadmium, the reducing action of the evolved hydrogen is found to be greatest with the magnesium, and least with the cadmium, which result Dr. Armstrong connects with the fact that in the solution of these metals, the greatest amount of heat is evolved by magnesium and the least by cadmium. But that the comparative reducing power of the hydrogen evolved by the action of the three metals stands in no direct relation to the heat developed on solution, appears to be evident from the circumstance that in the case of the deoxidation of solutions of vanadium pentoxide by the action of these metals, the very reverse obtains: magnesium added to the solution of the pentoxide forms the trioxide, and the liquid becomes green; under no conditions, apparently, is this metal able to bring about a lower degree of oxidation; on the other hand, zinc and cadmium carry the deoxidation a stage further, and a lavender-coloured solution of the dioxide is obtained. And it would further appear from experiments which are in progress by the writer of this notice, that the amount of hydrogen which is effective in the work of reduction, as measured by its power of deoxidising ferric sulphate, amounts, in the case of zinc, to about twenty-two per cent. of that which is evolved; whereas in the case of magnesium, under circumstances as similar as possible, it is only about eight per cent. This, indeed, is but a portion of the broad problem of the connection between the conditions of a chemical change and its amount, one side of which, as Dr. Armstrong shows us, has already been attacked by Messrs. Harcourt and Esson. We may add, in this connection, that it would have conduced to clearness if, in the concise account of the work of these chemists, the term "thiosulphate" had been substituted for that of "hyposulphite," since we have the existence of Schützenberger's acid duly stated a few pages further on, and it, in accordance with Henry Watts's suggestion, is called hyposulphurous acid.

Of the remaining portion of the article, namely, that on organic chemistry, we have but little space to speak. In one respect Mr. Meldola has had the most difficult share of the work, for it is no light task to be obliged to concentrate the essence of modern organic chemistry within less than forty pages. The general arrangement of this section bears considerable resemblance to that of Prof. Schorlemmer's excellent Manual of the Carbon Compounds, and although it, of necessity, cannot be attractive to the general reader, we can congratulate Mr. Meldola on having produced a compilation which will be highly serviceable to chemists. T. E. T.

PACKARD'S LIFE-HISTORIES OF ANIMALS

Life-Histories of Animals, including Man; or, Outlines of Comparative Embryology. By A. S. Packard, jun. (New York: Holt and Co.)

IN the rapidly-shifting condition of our knowledge of the development of all kinds of animals, it is a most difficult thing to produce a satisfactory treatise on Comparative Embryology. None the less such a work is much needed by our university students, and the little book which Dr. Packard has put together may be recommended to them as containing a great deal of the latest information on the subject, well illustrated by diagrams derived from a number of widely-scattered German, French, English, and American periodicals.

At first sight Dr. Packard's book appears considerably better than it really is. The student needs to be cautioned in using it, since it combines with much that is excellent a surprising amount of inaccuracy, and is sadly deficient in critical power. Dr. Packard is a student of German zoological journals, and is too ready to attach a large measure of importance to German work because it is German. Moreover, though he has himself engaged in researches on the embryology of the King Crab and of Insects, he has clearly not worked over a wide field in the subject, and consequently is not able to bring a trained experience to bear on the discrimination of the sound and the unsound observations and speculations of recent writers.

Amongst the good points of the book (to take some of these to begin with) we have a figure supplied by Dr. Bessels of his *Prötobathybius Robesonii;* the account and figures of various Monads from James Clark, Dallinger, and Drysdale; the text and figures relating to the Echinoderms; Lacaze Duthier's figures of developing *Dentalium;* figures relating to the development of Arthropods from the works of Bobretzky, Kowalewsky, and Ganin; Morse's figures of developing Terebratulina; Agassiz's Tornaria and Balanoglossus; Wyman's embryonic skates; whilst good figures of larval Ascidians are also given.

Whilst insisting on the service which the book will render to the young student, we shall now point to some of its shortcomings. In the first place it is somewhat misleading to call attention in the title of the book to the two pages which are devoted to man. The Vertebrata altogether, are not treated with the same proportion of attention, relatively to our knowledge of them, as are the lower groups of animals.

It may be pointed out that whilst giving a large number of very useful citations of recent embryological works, Dr. Packard is not uniformly careful to ascribe the use of the terms and genealogical hypotheses which he employs to their rightful authors. In his chapter on the life-history of the Mollusca, he makes use of the terms Trochosphere and Veliger which I introduced into embryological nomenclature in my paper on the Development of the Pond Snail (*Quart. Journ. Micros. Science*, 1874), which he cites at the end of the chapter; he does not, however, ascribe either the terms or the views connected with them to their author. I am induced to mention this omission specially, since Prof. Semper of Würzburg, in his last publication—a heavy octavo discussing the relationship between Vertebrates and Annelids—has made a leading feature of the Trochosphere, appropriating the name as applied by me and the doctrine connected with it, without the slightest acknowledgment. The impropriety of Semper's proceeding is the greater since he makes no mere passing allusion to the Trochosphere, but puts forward a "Trochosphere-theory" which is intended to eclipse the "Gastrula-theory" of Haeckel.

A few points amongst those which we have noted as blemishes may be conveniently cited in order of pages.

Page 3.—We read "Bathybius was first discovered by Prof. Wyville Thomson in 1869, in dredging at a depth of 2,435 fathoms at the mouth of the Bay of Biscay." It was not, but was described and named by Huxley in 1868. Thomson appears to have seen it in 1869, in a living state under the microscope, to judge from his description quoted by Packard. Presumably this was not the sulphate of lime with which Bathybius has since been identified by the same authority.

Pages 24 and 25.—Urella should be Uvella.

Page 54.—"We have by tearing apart a species of Sycandra (or Sycon) perhaps *S. ciliata*, which grows on a Ptilota, found the planula much as figured by Haeckel, Metschnikoff, and Carter, and anyone can with patience and care observe the life-history of the marine sponges." It would have been more satisfactory if Dr. Packard had told us whether the planulæ he saw were like the figures of Haeckel or those of Metschnikoff; they certainly could not have been like both. It is a mistake to dismiss one of the most difficult problems which is now baffling embryologists with the assurance that "anyone can with patience and care" solve it.

Page 96.—"Sprat" for young oysters should be "spat." Salensky's observation on the young oyster, and his erro-