THURSDAY, AUGUST 26, 1875

SCIENTIFIC WORTHIES

VI.—SIR CHARLES LYELL, BORN NOV. 14, 1797; DIED FEB. 22, 1875.

SINCE its last meeting the British Association has lost one of its oldest members and most illustrious presidents. There are some men the story of whose mental development and progress in scientific research may be taken as almost embracing the history, during their lives, of the science to which they devoted themselves. Of such men we have not many brighter examples than that of Sir Charles Lyell. For somewhere about half a century he continued in the van of English geologists, and so identified himself with them and their pursuits as to be justly taken as the leader of geological speculation in this country. The time has probably not yet come when his true position in the roll of scientific worthies can be definitely fixed. The revolutions of thought which have taken place within the last fifteen years, and in which, let it never be forgotten, Lyell himself bore a conspicuous and indeed heroic part, have so shaken old beliefs which once seemed securely based on the most cautious induction from well-ascertained facts, that even they who have most closely watched the march of events will probably shrink most from the attempt to estimate the full and true value of the work of his long and honoured life. It is not, then, with any aim at such an estimate, but rather to recall some of the leading characters of his work, that this brief *in memoriam* is now written.

Perhaps the best idea of the solid services rendered by Lyell to Geology is obtained by looking back at the condition of the science when he first began to study it, and by contrasting that state with the same subject as treated by him in the early editions of his "Principles." To men who had been compelled to gain their general view of geology from such works as Daubuisson's "Traité," the appearance of Lyell's volumes must have been of the nature of a new revelation. From vague statements about early convulsions and a former higher intensity of all terrestrial energy, they were led back with rare sagacity and eloquence to the living, moving world around them, and taught to find there in actual progress now the analogues of all that they could discover to have been effected in the geological past. The key-note which Lyell struck at the very outset and which sounded through all the work of his career was, that in geology we must explain the past by the present;—that the forces now in operation are quite powerful enough to produce changes as stupendous as any which have taken place in former times, provided only that they get time enough for their task.

These views were not promulgated for the first time by the author of the "Principles of Geology." In cruder form they had been earnestly urged by Hutton, and eloquently illustrated and extended by Playfair. But after much turmoil and conflict of opinion, they had very generally been allowed to sink out of sight. On the Continent, indeed, they had never excited much attention, and were for the most part ignored as mere vague speculation. Even in this country they had only been partially adopted even by those who professed to belong to the Huttonian school. So that it was in one sense as a new doctrine that they were taken up by Lyell and enforced with a wealth of illustration and cogency of argument which rapidly gained acceptance for them in Britain, and eventually led to their development in every country where the science is cultivated.

In one important respect, however, the doctrines taught by Sir Charles Lyell differed from those of his predecessors. Hutton and Playfair knew almost nothing of fossil organic remains. They were necessarily ignorant of the light which these can cast upon the past history of the globe. They had but a dim perception of the long and varied succession of the stratified formations embraced by their own terms Primary and Secondary. After their days, however, the labours of William Smith among the Secondary rocks of England showed that the strata of the earth's crust could be identified and classified in their order of age by means of the fossil animal remains contained in them. Then came the brilliant discoveries of Cuvier in the Tertiary basin of Paris and the rise of the science of Palæontology. It was now seen that the discussion of theoretical questions in cosmogony and the collection and description of minerals and rocks did not comprise by any means the whole of geology. Year by year it became more evident that, besides all its records of physical revolutions, the crust of the earth contained materials for a history of organic nature from early geological times down to the present day. In this transition state of the science there was manifestly needed some leisured thinker who could devote a calm judgment and a facile pen to the task of codifying the scattered observations which had accumulated to so vast an extent, and of evolving from them the general principles which they seemed to establish, and which, when clearly announced, could not fail greatly to assist and stimulate the future progress of geology. Such was the task which Lyell set before himself, somewhere about half a century ago, and in fulfilment of which his "Principles" appeared.

In that great work the twofold aspect of geology—its inorganic or physical side and its organic or biological side—was recognised and admirably illustrated. It was in the treatment of the first of these that the earlier editions of the "Principles" stood specially distinguished from previous writings. The leading idea of their author was, as already remarked, not original on his part. Besides the writings of Hutton, Playfair, and their followers, the appeal to history and to everyday experience as to the true nature and results of the present working of the various terrestrial agents had already been made in considerable detail by Von Hoff in Germany. Nevertheless, until the advent of Lyell's work the views he adopted had got no real hold of men's minds. It was his enforcement of them which secured for them first a careful examination, and ultimately a very general acceptance. In explaining former revolutions of the globe, geologists had usually proceeded on the tacit assumption that no serious argument was required to prove these revolutions to have been far more violent in their progress and stupendous in their results than could possibly have been

achieved by any such energy as is still left upon the earth. Accordingly, on the whole they were disposed to neglect the consideration of proofs of modern changes on the earth's surface, looking upon these as mere faded relics of the power with which geological changes were formerly effected. It is impossible to exaggerate the service which Lyell did to the cause of truth by boldly striking at the very root of this fundamental postulate of his contemporaries, and showing, by a wide induction of facts from all parts of the world, how really potent were the present apparently quiet and ineffective processes of change. With most uncompromising logic he drove it home to the hearts and consciences even of sturdy convulsionists, that they had all along been reasoning in a circle, and that the evidence on which they so confidently relied demanded and could receive another and very different interpretation.

It was a great matter to shake the old convulsionist faith and bring men back to the study of the actual operations of nature at the present time. Greatly more difficult, however, was the task to build up another creed and gain adherents to it. Yet this was accomplished by Lyell with an abundant measure of success. He came to be recognised as the great reformer in geology, the high priest of the Uniformitarian school, the leader under whom in this country the younger men eagerly ranged themselves. Through the influence of his writings a fresh and healthy spirit of scrutiny and observation spread through the study of geology. And as edition after edition of his work appeared, each more richly laden than its predecessors with stores of facts gathered from all branches of science in illustration of his subject, men were led to realise how narrow had been the old conception which limited the scope of geology merely to the study of minerals and rocks and the elaboration of cosmological theories. Every department of nature which could throw light upon the terrestrial changes now in progress and thereby elucidate the history of those which had taken place in former times was made to yield its quota of evidence. Hence it came about that the study of geology received in Britain a breadth of treatment which had never before been given to it either in this or any other country. The main share in this reform must be assigned to the genius and perseverance of Lyell.

But in science as in politics no reform can provide for all the requirements of the future. In proportion to the zeal with which the new creed is adopted and proclaimed, there may be and often is an inability to recognise such measure of truth as may have underlain the older faiths, as well as to realise the weak points in that which is set up in their place. The essential doctrine of the Uniformitarian School was in reality based on an assumption not less than those of the older dogmas. It was an assumption indeed which did not rest on mere crude speculation, but on a wide range of observation and induction, and it claimed to be borne out by all that was known regarding the present economy of nature. It professed to be in accordance with the logical method of reasoning from the known to the unknown. Nevertheless, in the course of years the Uniformitarians gradually lost sight of the fact that the present order of nature on which they asserted that their system rested could not, without a manifest and perhaps in the end an unwarrantable assumption, be taken as the standard whereby the order of nature in all past geological time was to be gauged. The information gained by human observation during the few centuries in which man had taken intelligent interest in the world around him was valuable as a basis for hypothesis, but only for hypothesis which should be cast aside so soon as the requirements of a wider knowledge might demand. The Uniformitarians, however, gradually slid into the belief that though perchance they had not absolutely proved terrestrial energy never to have been more powerful than at present, yet they had shown that the supposed proofs of former greater intensity were illusory, and hence that their own doctrines should be accepted as by far the most reasonable, and indeed as the only safe guide in the interpretation of the past history of the earth. Most admirable has been the work done by the Uniformitarians, and deep are the obligations under which Geology must ever lie to them. But in the onward march of mental progress it is now their turn to have their confident belief called in question. Another School is rising among them, accepting from them by far the larger part of their doctrines, but in their own spirit of bold inquiry and with their own zeal in the cause of truth, seeking to enlarge the basis on which our ideas of the full sweep of nature's operations are to rest.

The other, or biological side of geological science, owes much of its development to the skill with which it was handled in the successive editions of the "Principles." Though not himself in the strict sense either a zoologist or botanist, Sir Charles Lyell throughout his life kept himself abreast of the progress of the biological sciences and on terms of intimate relationship with those by whom that progress was sustained in this country and abroad. He was in the true meaning of the word a naturalist. He had in his day few equals in the grasp which he could take of natural history subjects in their geological aspects. The geographical distribution of plants and animals was one of those subjects which received more and more ample treatment from him as he advanced in years. The succession of living forms in time was another theme which gave him full scope for accurate and eloquent description. In fact, the breadth of his conception of what geology ought to be was not less conspicuously marked in this than in the physical department of the science. He enlisted in his service every branch of biological inquiry which could elucidate the former history of the earth and its inhabitants. And not merely the published information on these questions, but many of the floating ideas of discoverers found exposition and illustration in his pages.

One of the biological subjects to which he devoted much time and thought was one which in recent years has received renewed attention and provoked increased discussion—the origin of the successive species of plants and animals which have appeared upon the earth. During the greater part of his career Sir Charles Lyell distinguished himself as one of the most uncompromising opponents of development theories such as those of Lamarck and the author of the "Vestiges of Creation." Such views ran counter to his uniformitarian faith, and he brought against them a large armoury of geological weapons. The non-appearance of higher

types of life among the older formations he contended to be no evidence in favour of development. It was simply negative evidence, and could at any moment be destroyed by the discovery of one positive fact in the shape of a bone, tooth, or other fragment. No one could make better use than he of such fortunate finds as that of Dr. Dawson among the ancient carboniferous forests of Nova Scotia, when from the heart of a fossil tree quite a little museum of land-snails and lizard-like forms was obtained; or those which revealed such remarkable assemblages of little marsupial and other mammalian forms from thin and local deposits like the Stonesfield slate and Purbeck beds. But negative evidence, when multiplied enormously by observers all over the world without any important contradiction, becomes too overwhelming to be explained away. Though convinced of the untenableness of the views of development which he opposed, Sir Charles may have had his misgivings at times that the yearly increasing and enormous body of negative evidence in favour of the non-existence of higher types of life in the earlier geological periods could not be due to the mere accident of non-preservation or non-discovery. At all events, when Mr. Darwin's views as to the origin of species were made known, Sir Charles, recognising in them the same basis of wide observation and the same methods of logical analysis for which he had himself all along contended in geology, at once and zealously accepted them—a bold and candid act, seeing that it involved the surrender of opinions which he had been defending all his life. In no respect did he show his remarkable receptive power and the freshness with which he had preserved his faculty of seeing the geological bearings of new truths more conspicuously than in the courage and skill with which he espoused Mr. Darwin's hypothesis and proceeded at once to link it with the general philosophy of geology.

Of his work among the Tertiary formations, with the nomenclature by which, through that work, they are now universally known, his observations on the rise of land in Sweden, his researches into the structure of volcanic cones, and other original contributions, over and above the solid additions to science supplied by the numerous editions of his popular works, it is not needful to make mention here. Enough is gained if at this time these few lines recall some of the services to which Sir Charles Lyell devoted a long, honourable, and illustrious life, which have graven his name in large letters on the front of the temple of science, and in memory of which that name will long be remembered with gratitude and enthusiasm as a watchword among the students of geology.

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WATTS' DICTIONARY OF CHEMISTRY

A Dictionary of Chemistry and the Allied Branches of other Sciences. By Henry Watts, B.A., F.R.S., &c. Second Supplement. (Longmans, Green, and Co., 1875.)

THE appearance of the second supplement to Watts' "Dictionary of Chemistry" is an event in the history of chemical literature which will certainly be elcomed by all English chemists. Although it may be said with truth that no great generalisations have been made of late years in chemistry, the science is nevertheless advancing with gigantic strides so far as the accumulation of facts is concerned. Perhaps no science possesses such an extensive journalistic literature as Chemistry; month after month the journals of the Chemical Societies of London and Berlin, the *Gazzetta Chimica Italiana*, the *Annalen der Chemie*, *Poggendorff's Annalen*, the *Annales de Chemie*, the proceedings and transactions of the various learned Societies, as well as numerous smaller chemical publications, all contribute to the vast store of facts already recorded. It is not to be wondered, then, that during the nine years which Mr. Watts devoted to the compilation of his dictionary, the science should have continued its growth at such a pace that the author found it necessary to promise on the completion of the work (Preface to Vol. V., 1869) a supplementary volume bringing the record of discovery down to the existing state of knowledge. The first supplement accordingly appeared in 1872, bringing the history of the science down to the end of 1869. The volume now before us carries the record of discovery down to the end of 1872, and includes some of the more important discoveries made in 1873 and 1874.

From the contents of the present supplement we cannot select more than a few of the longer articles for notice here.

Turning first to the article on benzene, one cannot fail to be struck with the rapid growth of our knowledge of this body and its derivatives within the last few years. The list of haloid, nitro-haloid, &c., derivatives has been considerably increased since the publication of the last supplement by the discovery of new isomeric modifications of these bodies—modifications the discovery of which cannot but be regarded as signal triumphs to chemical theory when we call to mind the fact that the impetus given to the study of benzene, the fundamental hydrocarbon of the aromatic series, arose from the theoretical speculations of Kekulé and his school.

The subject of capillarity is treated of with considerable detail in an article some nine pages in length. The development of this subject is due to the researches of Quincke, Karmarsch, Buliginsky, Valson, and others. The article on chemical action contributes much of importance to the subject: we may particularly mention Mill's researches on the co-efficient of chemical activity, the numerous researches by Berthelot, in conjunction with Jungfleisch on the division of a body between two solvents, and with St. Martin on the state of salts in solution; likewise Favre and Valson's experiments on crystalline dissociation. Passing on to the cinchona alkaloids, we find that three new substances—quinamine, paricine, and paycine—have been added to the list by Hesse. The "constitution" of these cinchona alkaloids is among the problems still awaiting solution at the hands of chemists—may it not be hoped that the synthesis of quinine will one day—as that of alizarine—be a chemical possibility? In electricity, the chief additions to our knowledge are Becquerel's experiments on electro-capillary action, Quincke's theory of electrolysis, and Guthrie's experiments on the relationship between heat and electricity. The mechanical theory of gases has developed into a separate article of considerable importance in our eyes.