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SCIENTIFIC WORTHIES.

XXXVII.—Sir William Ramsay, K.C.B., F.R.S.

If we endeavour to build up to its highest pinnacle Auguste Comte's pyramid of sciences, in which natural science follows upon mathematics, and is succeeded by physiology, and finally by sociology, we reach as the highest of imaginable sciences the science of Geniology, the science of genius, of the excelling man. That such a science is possible has been known for half a century. The investigations of Sir Francis Galton in England, of de Candolle in Geneva, and of some recent workers in Germany, have proved to demonstration that even this rare and shining phenomenon is subject to definite natural laws, discoverable by a careful scrutiny of available facts, laws the significance of which is very great, since the position of any nation among the nations of the world is determined by the qualities and the efficiency of its men of genius.

On surveying the life of Sir William Ramsay in the light of this the youngest of the sciences, one is struck by the extraordinary consistency to be found in it, a consistency by virtue of which the rapid succession of astonishing discoveries filling the latter portion of his life appears as the necessary consequence of a natural and regular process, and almost resembles the working of a machine. Here we find nothing of the irregular curves with distinct maxima occurring in other types of genius, and usually in the most marked degree in youth, as in the case of Sir Humphry Davy, Sir William Ramsay's fellow-countryman, who resembles him in many respects. Ramsay recalls Davy by the brilliancy and the striking originality of his discoveries, which had no relation with any school or predecessor. In Davy's case these discoveries appear more as disconnected peaks suddenly arising from an average level. In Ramsay's case, on the other hand, we can observe how one discovery follows another, how comparatively modest and unobtrusive investigations, which have been accepted in their due place in the great register of the sciences, appear as the necessary foundations for truths of such novelty that their possibility was not even conceived before they were scientifically communicated.

This natural-law consistency is seen in the first instance in William Ramsay's descent. He has himself explained that his male ancestors for seven generations were dyers, thus handing down to him as a long inheritance a familiarity with chemical processes and a facility in chemical ways of thinking. On the mother's side, again, a series of physicians have provided the inherited capacity of the great scientific discoverer. But of all these men, none even remotely resembles Sir William in his eminence among his contemporaries, and, in this case, as in all similar cases, the question arises, how it is possible that such a genius arises from people of good average capacity.

It has, indeed, been established by Galton that an efficiency exceeding the average, but not amounting to genius, is in some families inherited through a whole series of generations. But here we have to deal with one of those extraordinary cases where an average efficiency was well evidenced through a number of generations, but suddenly made way for an incomparably higher personality, in which indeed the characteristic qualities of previous generations can be recognised, but which far surpasses its progenitors in efficiency.

If we bear in mind the well-known laws of heredity discovered by Mendel and de Vries, we know that every descendant is a mosaic of those qualities which have been transmitted to him partly by the father and partly by the mother. In the face of this fact the problem arises how such an unusual personality can be descended from parents of average ability, since it is just from these laws of heredity that we should conclude that another average equipment would result.

The answer which I tentatively should venture as regards this problem is this: The portions of the inheritance constituting a new being probably only on rare occasions fit together or harmonise with each other. The adolescent man then applies the greatest portion of his energy in the task of organising these accidental inheritances for the purpose of common work and harmonious cooperation, and this task uses up the greater part of the available energy, and withdraws it from productive work. It is only in rare cases that the inheritances are so constituted that they fit each other from the beginning, so that the young man has not to expend any energy on the mutual harmonising of his elements, but can immediately set about his creative work. Such a case seems to be that of Sir William Ramsay. On one occasion he described himself as a precocious, dreamy youth, of somewhat unconventional education. The precociousness is a practically universal phenomenon of incipient genius, and the dreamy quality indicates that original production of thought which lies at the basis of all creative activity.

His father, being a man of practical pursuits, who, however, in his free time zealously cultivated scientific works, such as quaternions and geology, introduced young William to the great passion of his life, chemistry, and, as is often the case, an accident was the immediate cause of the new departure. Young William had broken a leg at football, and to ease the tedium of convalescence, his father had given him Graham's "Chemistry" to study, and also brought him small quantities of many chemicals with which he could carry out the experiments described in the text-book. Sir William himself says that it was chiefly the question how fireworks could be prepared which induced him to study Graham's "Chemistry." But very soon the general scientific interest gained the upper hand, and this can very characteristically be gathered from the fact that he persuaded his people to

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take a practical part in the pursuits which interested him. In his fourteenth year William matriculated at Glasgow University, and there commenced his studies. The greatest influence was exerted upon him by William Thomson, whose curious and impressive method of teaching has been graphically and amusingly described by his great pupil. He gave him as a first problem a large heap of old copper wire in the laboratory, and instructed him to take out the kinks from it, and from the way in which the young student accomplished the task Thomson seems to have derived a favourable judgment as to his capacity for solving larger problems. For he soon made him acquainted with the quadrant electrometer, an instrument which at that time only existed in Glasgow, and instructed him to determine the potential difference between all kinds of objects found in the laboratory, or imported into it, such as a children's toy balloon. We can imagine that if such an originally constituted spirit could be at all affected by teaching, he must have been profoundly affected by this teacher. For William Thomson belonged to the same type of "romantic" or rapidly producing investigators as did Ramsay himself, and hence he made a particularly strong and permanent impression on that plastic developing genius.

The regular study of chemistry which followed upon this irregular course was made under Tatlock in Glasgow, and in this case also Ramsay appears to have distinguished himself so decidedly that his teacher after a short time made him an occasional deputy in the class.

At eighteen years of age the young student in Glasgow had learned whatever was to be learned there, and he had now to pursue his further study of chemistry. For this only Germany was at that time to be considered. But the Franco-German War had just broken out, and it therefore appeared somewhat risky to follow the original idea of continuing his studies in Heidelberg under Bunsen. However, the scene of war moved away so rapidly from the Franco-German frontier, that the German project could be undertaken. Ramsay passed one term with Bunsen, without, however, seeming to carry away a very strong impression, for in the following term he moved on to Tübingen, where he met a number of equally disposed fellow-workers in Fittig's laboratory, and under the guidance of this extremely conscientious teacher and able experimenter he was introduced to the usual problems and methods of organic chemistry. There Ramsay made one of the usual dissertations (on toluyl acids), which does not enable us to recognise the kind of man we have to deal with. After his return Ramsay was for some years assistant in the Glasgow course of study, and there he acquired a very extensive and profound knowledge of the whole field, especially of inorganic chemistry, at the same time laying the foundations of that mastery which he subsequently displayed as teacher in a great laboratory. Nor shall we err in supposing that the method of working a laboratory, as developed under the inspiring guidance of Liebig in Germany, and spread over the laboratories of the whole world as common property of chemical science, has exerted a very profound influence on Ramsay's talents and ideals as a teacher. In any case, we can state that he has approached the great example of Liebig as closely as any distinguished teacher of chemistry since that great time. Particularly in England his extraordinary facility of organising work in a great laboratory, with a diversity of the most varied talents, must be regarded as very rare, considering that they spread over many different regions of science, and thus make results possible which turn out afterwards to be of fundamental importance.

It is very interesting to observe from Ramsay's own communications how he gradually found his way out of organic chemistry, at that time the object of chief interest, into that other region which has since found an independent place as physical, or rather general chemistry. It was first certain practical problems, such as the determination of vapour densities, which introduced him to the more physical problems of chemistry. Here we find the first marks of the growing genius, in the extraordinary independence in the choice of means of solving the problem. Thus he used the pitches of pipes of fixed dimensions for the determination of vapour densities, and thus utilised his own musical talents.

This process was successful (although it has never been published), but he was less fortunate in his attempts to measure the electric conductivity of solutions by means of the telephone. Here we are involuntarily brought to a pause and have to ask ourselves how the geographical distribution of discoveries in electrochemistry, such as have reformed chemistry in the last twenty years, would have arranged itself if the young investigator had at that time been more fortunate in the execution of his experimental ideas.

We also know of physiological investigations concerning anæsthetics, dating from this period, executed in company with some medical colleagues. In these he himself was the experimental subject, as he suffered less under them than his companions. But here also no considerable results were obtained.

The first independent position was obtained by William Ramsay in the year 1880, when the professorship at the University College, Bristol, was entrusted to him. The choice fell upon him in preference to a competitor because, as he himself narrates, he understood Dutch. For he had to make visits to the various members of the council of the College, and was fortunate enough to be of assistance to one of them, an old minister, in the translation of a Dutch text, so that this member gave him his vote, and the choice was made with a majority of one. But soon it turned out to be an exceptionally happy one. A year after that Ramsay was chosen as the principal of the College. In this short time he had not only proved himself to be an excellent teacher, but also an excellent organiser.

The problem of vapour densities, which had first introduced him to physical chemistry, gave rise to further investigation, in the course of which the habit of expressing experimental results by mathematical formulæ, learned from Sir William Thomson, turned out to be extraordinarily valuable. In this connection originated the fundamental works on evaporation and dissociation, carried out in great part with his assistant, Sydney Young, which first drew the attention of the larger circles of the scientific world upon him. Here also it is suggestive to note how one followed on the other. His intervention in a controversy which was at that time raging in the columns of NATURE concerning "hot ice" suggested to him the possibility of determining the relation between vapour pressure and temperature by introducing into a space under the pressure in question a thermometer the bulb of which was covered with the body under investigation, in this case ice. The resulting temperature corresponding to the pressure turned out to be so precise that the process was soon developed as a general method of determining vapour pressure.

These investigations, which have been published in a number of large essays in the Philosophical Transactions, gave the impetus which led to the appointment of the still youthful professor to the highly esteemed chair at the University College, London, which Sir William Ramsay still adorns. It is true that at that time the great value of these works was imperfectly recognised, and I remember having an opportunity of pointing out to the authorities of the University College with great emphasis that we had here to do with investigations carrying us considerably further than the determinations of the great physicist Regnault, who was then regarded as the first authority on the whole subject.

At this point began the rapid succession of works which brought Ramsay to the scientific eminence which he still occupies. The measurements of surface tensions up to the critical temperature led to the well-known law which allows us to determine molecular weights in liquids. An occasional lecture experiment, during which magnesium nitride was produced, suggested to him to cooperate with Lord Rayleigh in the solution of the problem proposed by the latter concerning the difference in density between nitrogen derived from the air and artificial nitrogen.

By heating nitrogen from the air repeatedly with metallic magnesium, he succeeded in producing a gas that became ever denser, and turned out to be decidedly different from nitrogen itself. At the same time, Lord Rayleigh solved the problem of separating nitrogen from a possible other gas by the repetition of an experiment devised by Cavendish a hundred years earlier. Both these excellent investigators combined for joint continuation of this work, which led to the discovery of argon, the first type of a new class of elements.

But when an element of a new type had been found, the periodic law immediately suggested the existence of a number of other elements of the same type. Thus Ramsay succeeded in a short time in discovering the element helium, belonging to the same group, in certain rare minerals. An incidental occupation with a litre of liquid air, then first made in London by Hampson, led shortly afterwards to the discovery of three further elements of the same type—neon, krypton, and xenon—which were separated from each other and described, using in many cases quite novel methods of determining their properties. Thus while other discoverers were satisfied with single new elements, Ramsay discovered a whole class of elementary substances.

Then when in 1896 Becquerel demonstrated during his stay in Paris his newly discovered dark rays of uranium from which later the discovery of radium resulted, Ramsay showed the keenest interest, and undertook in his own laboratory an investigation of these phenomena.

This work led up to the greatest discovery made by our great investigator, the discovery of the real transmutation of one element into another. The gaseous emanation of radium, which at first had behaved as an entirely new body, showed after some time the lines of helium, and, finally, it was definitely proved that radium in its spontaneous decomposition produced helium in a perfectly regular way. If Ramsay had not come to know helium beforehand as his own child, so to speak, and if he had not, in the course of his work on rare gases, acquired the skill of working with almost immeasurably small quantities of such substances, he would probably not have succeeded in this capital discovery, which placed him among the very first chemical discoverers.

Following upon this work, Sir William Ramsay originated a series of other investigations, some of which are not yet finished, and cannot therefore be dealt with in this place, more especially as he is still at an age at which we may expect great and manifold achievements from him which preclude a final judgment upon his work.

But it may be possible to describe the general type to which Sir William Ramsay belongs as a discoverer. It has already been said that he undoubtedly belongs to the "romantic" type, working with an unusual speed of reaction, and marked by rapid and various productions. The marked peculiarity of this type of investigators, which enables them to train a great number of budding talents and to spur them to extraordinary efforts, has been brilliantly brought out. We may regard the physico-chemical school of Sir William Ramsay as the most important chemical school of his country for a large number of years. He has not been spared the fate of the "romantic" school, inasmuch as he has on occasion made an error in his discoveries. When the unheard-of number of new elements derived from the air rattled down upon the astonished world of chemists, one of these elements, which had been given the name metargon, on account of its similarity with argon, turned out to be carbon monoxide, which had entered the gases by an impurity in the phosphorus. This error did not do much damage, especially since, as Sir William Ramsay remarks himself, there is always in such a case a large number of good friends who hasten to point out and correct such inaccuracy.

Here we have a life in which merit and good fortune have combined as they rarely do. No external difficulties have stood in the way of the straight-line development of the growing spirit, and the acknowledgments of his contemporaries have crowned his great merits soon enough to give his life the benefit of such stimulus. Thus he has come to be one of the great *international* investigators, known wherever science is cultivated. If we add that Sir William personally belongs to those unassuming and agreeable figures such as can only be found in the small circle of the front-rank men of science, and that his domestic fate, though not free from occasional cares, has given him a more than average degree of contentment, we have stated the conditions which lead us to expect that his sixtieth year of life, which he will shortly complete, will not by any means mark the close of an unusually rich and fruitful life's work.

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ARCHÆOLOGY IN THE "ENCYCLOPÆDIA BRITANNICA."

Collection of Articles (loose sheets) dealing with Ancient History and Archaeology, from the New (11th) Edition of the Encyclopaedia Britannica. (Cambridge University Press, n.d.)

IN no department of knowledge has greater progress been made during the last twenty years than in the realms of archæology and ancient history. A glance at almost any volume of the new edition of the "Encyclopædia Britannica" will bring this fact forcibly home to anyone. By means of the supplementary volumes, which were issued as an appendix to the tenth edition, it was attempted to summarise the course of such progress, and the result was certainly a series of interesting monographs by specialists, whose efforts were, however, largely controlled and cramped by the existence of articles on the same subjects in the earlier volumes, which were admittedly out of date. No such disadvantage characterises the eleventh edition. In fact, this new edition establishes a record of its own by the simultaneous issue of the whole of its twenty-eight volumes. Thus the purchaser has not to wait for years for the work to be completed. On the contrary, he obtains at once a marvellous summary of knowledge, every part of which has been subjected to a final revision by its author at the time of going to press. The amount of labour and organisation which must have been required to bring such a plan to a successful issue is little short of marvellous, and the editor has certainly reason to congratulate himself on the achievement.

His task must have been particularly arduous in keeping the archæological articles abreast of the most recent research. Yet in this section of the work, wherever we have tested it, he has not failed. Take, for instance, such an article as that on Ægean civilisation in the first volume. Here we have an admirable summary by Mr. D. G. Hogarth of the gradual discovery of the remains and their distribution, and a discussion of the general features of Ægean civilisation based upon them; yet even in such a moot section as that on the chronology, we find he has been enabled to make use of data quite recently acquired. The same remark applies to the series of careful monographs on ancient Egypt which have been contributed by several specialists, and to that on Babylonia and Assyria, the greater part of which is from the pen of Prof. Sayce. We have mentioned these three articles in particular as dealing with departments of archæology in which additions to our material and information are being constantly made. Yet, though they all occur within the earlier volumes, they represent the present state of our knowledge equally with those in the final volumes of the work.

With such a wealth of material to choose from, it is difficult to do more than indicate some of the more important and striking features of the present edition. In the arrangement of the material we have noted what appears to us an admirable innovation, the greater weight and prominence given to the general article. On one hand this enables a writer to lend additional interest to his subject by treating it from a more personal and less encyclopædic point of view. Such an article is Mr. C. H. Read's, on archæology, in which he has space, not only to summarise the headings of his subject, but also to discuss its value as a branch of science and the progress that has been made in its organised study. Thus, when dealing with the primitive epochs in the history of man, we note Mr. Read's timely warning to students of prehistoric archæology to use caution in their treatment of that much-debated problem as to whether traces of man have actually been found in deposits of the Tertiary period. As Mr. Read points out, there is no valid reason against the existence of Tertiary man, but the evidence in favour of the belief is not very convincing. For, on one hand, there is considerable doubt as to whether the deposits containing the remains are without doubt of Tertiary times; and, on the other, it is not certain whether the objects found show undoubted signs of human workmanship. On the latter point, a recurrent difficulty, and one which can never be entirely removed, is our ignorance of the precise methods of nature's working. It is certain that natural forces, such as glacial action, earthquake, landslips, and the like, must crush and chip flints and break up animal remains, grinding them and scratching them in masses of gravel or sand. It is almost impossible to separate the markings or crushing of flint and bone due to such natural agencies from others which may have been purposely made by man to serve some useful end. Even the one feature which is commonly held to determine human agency, the "bulb of percussion" (the lump or bulb on the face of a flint weapon at the end where the blow was delivered to detach it from the mass), is not conclusive evidence; for recent investigations have shown that natural forces frequently produce a similar result. Mr. Read's advice in deciding knotty points of this character may be summarised: use caution, and, where possible, obtain collateral evidence of some kind.