The Scientific Outlook

IT IS CUSTOMARY in all branches of science to associate the names of eminent men with the facts and principles discovered by them which form the foundations of the subjects. This practice is found to be useful since it helps to abbreviate and give precision to the terminology of science. It also serves to commemorate the name and fame of the leaders of science whose labours have helped to create a subject. Indeed, this is how the student of science first gets to know the names of the great leaders in his subject. The touch of human interest which the study of science gains in this way is of no small value, since it emphasises the real nature of science as a living and growing creation of the human spirit.

A study of the history of individual branches of science and of the biographies of the leading contributors to their development is essential for a proper appreciation of the real meaning and spirit of science. They often afford much more stimulating reading than the most learned of formal treatises on science. To the teacher, such histories and biographies are invaluable. Whenever he finds the attention of his listeners flagging a little, he can always enliven his class by telling a little story of how this or that great discovery in his subject was made or by recalling some anecdote about one or another of the famous investigators in the field. In this way, the teacher can convey to the student an understanding of how science is made and of the intellectual outlook which is the essence of it.

What is meant by a scientific discovery? How is it made? These are questions of perennial interest which are often asked and to which the most varied answers have been returned. A discovery may obviously be either of a new fact or of a new idea. It is clear however that an unexplained observation is of no particular significance to science. An idea unsubstantiated by facts is equally devoid of importance. Hence to possess real significance a scientific discovery must have both an experimental and a theoretical basis. Which of these aspects is the more important depends on the particular circumstances of the case, and a rough distinction thereby becomes possible between experimental and theoretical discoveries. Rontgen's discovery of X-rays, for example, was clearly an experimental one, while Planck's equally important discovery of the quantum of action was clearly in the field of theory. The manner in which a scientific discovery is made and the attitude of the investigator which makes such a

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discovery possible are obviously very different in the two cases. This distinction between the attitudes of the experimenter and the theorist is most obvious in the mathematical sciences. It is much less obvious in those sciences which rest more exclusively on an empirical foundation and in which observation of facts and thinking about facts are less easily separable processes.

The word discovery suggests a dramatic and exciting event, like finding a fifty-carat diamond in a ploughed field, for example. The history of science is indeed full of such dramatic discoveries, the drama and the excitement being particularly manifested in the personal behaviour of the scientist immediately following the event. I could tell one or two stories myself of such incidents in the life of a scientist. The classic story is that of Archimedes who rushed into the street straight from his bath with nothing on, crying "Eureka eureka", when his famous principle of hydrostatics flashed into his mind. The point of the story is the intense emotion aroused by a sense of the overwhelming importance of the new idea. The joy and exaltation felt at such a moment are indescribable. Indeed, such dramatic moments come into the life of even the most devoted follower of science but once or twice in his career. They are the greatest reward of a lifetime spent in the pursuit of knowledge for its own sake. Lesser discoveries come oftener and are a source of profound satisfaction and encouragement to the investigator. But they do not make such soul-stirring drama.

It should be mentioned that the reception given at first to even capital discoveries by the outer world is not always one of respectful admiration for the achievement of the discoveries. One of the commonest ways in which the achievement is sought to be minimised by the unthinking or the envious is by attributing it to accident or a stroke of luck akin to the winning of a lottery ticket. Such comments are of course deplorable and indeed quite meaningless. The idea that a scientific discovery can be made by accident is ruled out by the fact that the accident, if it is one, never occurs except to the right man. The happy discoverer in science is invariably a seeker after knowledge and truth working in a chosen field of his own and inspired in his labours by the hope of finding at least a little grain of something new. The commentators who like to consider discoveries as accidents forget that the most important part of a scientific discovery is the recognition of its true nature by the observer, and this is scarcely possible if he does not possess the requisite capacity or knowledge of the subject. Rarely indeed are any scientific discoveries made except as the result of a carefully thought-out programme of work. They come, if they do come, as the reward of months or years of systematic study and research in a particular branch of knowledge.

If the world is sometimes slow to recognize the importance of fundamentally new experimental facts, it is not to be wondered at if it is slower still in appreciating and accepting new theoretical ideas. Usually, such new ideas are looked upon with indifference or suspicion, and many years of persistent advocacy and powerful observational support are required before the investigator can hope to see his ideas generally accepted. The story is often told of Arrhenius and the doctorate thesis which he presented to Stockholm University containing his new ideas regarding the nature of solutions, supported by a great volume of experimental data. All that he received for his epoch-making work was a fourth-class degree permanently disqualifying him from an academic career. Arrhenius happily survived this experience, and lived to receive the Nobel Prize and to be venerated as his country's greatest scientist. But there are, unhappily, other instances of youthful genius being repressed and completely suppressed as well.

If there is one fact more than any other which stands out in the history of science, it is the remarkable extent to which great discoveries and youthful genius stand associated together. Scores of instances can be quoted in support of this proposition. Indeed, if one were to attempt to write a treatise on any branch of science in which all discoveries made by youthful workers were left out, there would be very little left to write about. The fact of the matter appears to be that, other things being the same, the principal requisite for success in scientific research is not the maturity of knowledge associated with age and experience, but the freshness of outlook which is the natural attribute of youth. The conservatism which develops with increasing age is thus revealed as a factor which militates against great achievement in science. The great ideas seem to come most easily to youthful minds. Since however much time is required to work out a new idea properly and fully, age and experience are not altogether useless in science. Up to a certain point, the conservatism bred by age may even be useful as a brake on the wilder flights of youthful imagination. Further even the elderly may, if they so choose, retain and cherish a youthful spirit and outlook. So long, therefore, as they do not allow the conservatism of age to function as a suppressor of youthful genius, the elderly may continue to find themselves useful as guides and inspirers of research. On this view, indeed, the principal function of the older generation of scientific men is to discover talent and genius in the younger generation and to provide ample opportunities for its free expression and expansion.

So far I have said little about the nature of the urge which leads the elite few to devote themselves to science and live laborious days in its service. This is a part of the larger question, what is it that drives men to devote themselves to any type of idealistic activity?

I think it will be readily conceded that the pursuit of science derives its motive power from what is essentially a creative urge. The painter, the sculptor, the architect and the poet, each in his own way, derives his inspiration from nature and seeks to represent her through his chosen medium, be it paint, or marble, or stone, or just well-chosen words strung together like pearls on a necklace. The man of science is just a student of nature and equally derives inspiration from her. He builds or paints pictures of her in his mind, through the intangible medium of his thoughts. He seeks to resolve her infinite complexities into a few simple principles or elements of action which he calls the laws of nature. In doing this, the man of science, like the exponents of other forms of art, subjects himself to a rigorous discipline, the rules of which he has laid down for himself and which he calls logic. The pictures of nature which science paints for us have to obey these rules, in other words have to be self-consistent. Intellectual beauty is indeed the highest kind of beauty. Science, in other words, is a fusion of man's aesthetic and intellectual functions devoted to the representation of nature. It is therefore the highest form of creative art.

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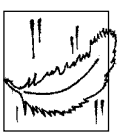

The Nobel Medal of C V Raman