PASSENGER PIGEON

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DEMOCRATS AND ARISTOCRATS IN SCIENTIFIC RESEARCH

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MOTIVES, methods, and enthusiasm in approaching and conducting scientific research certainly are as widely different as those in any other form of public endeavor. This is perhaps obvious enough to those accustomed to think in research terms. The public at large, it may be said, does not think in such terms, and has an indistinct notion as to what scientific research is. And this is not to be wondered at, for the public at large is not in the habit, not to mention the mood, of following scientific publications and so is largely dependent for its information upon a daily press, out of its depth entirely where science and exact truths are concerned. Much of the press knows a great scholar and gentleman, William Osler, chiefly, if not solely, for a chance, half-chaffing remark on longevity. In guileless simplicity it hails an untried adventurer sailing for southern seas in search of the "missing link" as a new Darwin, and it will continue in sublime ignorance of the stupendous amount of scientific material submitted to a critical world by that retiring but superhumanly able observer, to regard the distinguished biologist as the one original "monkey man" of all time.

Yet a public so educated, even with the movie scientist as the prototype of the species, dimly classifies research men into two groups. The one, alert to the present, includes the physician driving with all the power of his trained mind toward the achievement of a "cure" for one of mankind's maladies, and the engineer or botanist contriving methods which will make the desert blossom as a rose. In the other, we find an irresponsible person, perhaps damned with faint praise as an intellectual, given to investigating minute details of unimportant subjects, fussy and irritable if disturbed in his meditations or laboratory procedures, and prone to have beautiful if undeserved daughters, popular and addicted to the habit of staying out late nights. And after all, with some modifications, the classification holds, if one deserts the movies and views the latter creature on his own plane. It is this group, the science-for its-own-sake and knowledge-as-its-own-reward crowd, that we may designate as the aristocrats of science, in contradistinction to that other class, impatient, often as closely altruistic as it is given to man to be, who from their ardent endeavors in the direction of popular

demand and rigid dependence on the wishes of the *people*, may be labeled with the over used and much abused word democrat.

In the passing of William Osler and Emil Fischer of Berlin, science has in the past year lost two of the foremost minds of the century. Widely different in their fields of scientific endeavor as well as in their manner of cultivating them they may serve to illustrate anew the distinction drawn above.

Osler spent his life among people, giving to the full of his own strength and skill in the personal effort at the bedside, and outside as a great organizer. He was a member of innumerable societies and committees with the avowed purpose of promoting human welfare in one form or another. His objects are understandable to all. To heal the sick, to prevent suffering, to teach others to do the same, these are things that come within the range of common experience. He was a profound student of tuberculosis and every one knows what tuberculosis is, of typhoid fever, and diseases of the heart. A layman picking up his papers of twenty years ago on cancer of the stomach could see at a glance what he was driving at, might recognize the cuts, and with a little effort understand something of the pathology. His great textbook which went through many editions, has traveled far, being often seen on the "Science Shelf" in the smallest of village libraries. His name is familiar consequently to some of the most superficial of readers and because of the nature of his subject he is a person to them, where to the same individuals Fischer would be "a book."

The enthusiasm he aroused in his students is characteristic of the man. His own life-long student's attitude-that same spirit which used to lead him to say, "And now let us see where we made our mistakes," as he marched into the old autopsy room at Montreal-kept him on earth as far as his pupils were concerned and made him approachable to all. There was a very human touch to his work that belonged not merely to its nature but perhaps much more to his treatment of it. It must have been a primal urge, something essential in the man, which led him to devote himself to the people in such a way. His campaign must have been for end results, however interesting the preceding discoveries were of themselves. If he studied typhoid fever, in the last analysis it must have been with the object of preventing typhoid fever and making it unnecessary to study it, not for the mere acquisition of knowledge of typhoid fever for its own sake. Twenty years ago, commenting on the waste of life from this disease due to ignorance and neglect, he said, "Very different from death which comes with friendly care to the aged, to the chronic invalid, or the sufferer with some incurable malady, is that from typhoid fever. A keen sense of personal defeat in a closely contested battle, the heart searching dread lest something had been left undone, the pitifulness of the loss, so needless—

and as a rule in the 'morn and liquid dew of youth'—the poignant grief of parents and friends, worn by the strain of anxious days and still more anxious nights—these make us feel a death from typhoid fever to be indeed a Delian sacrifice. For fifty years the profession has uttered its solemn protest as I do this day; we have done more—we have shown how the sacrifice may be avoided and the victims saved." The marked decline in the incidence of typhoid fever in late years, due to the combined efforts of medical men, sanitary engineers, and public health officials, must have given Osler untold satisfaction.

But if William Osler was a public personage whose life played a part, great or tiny, in that of every one of us who has known what it is to be sick, what shall we say of the incomparable Emil Fischer, perhaps the greatest organic chemist who ever lived, whose place in the history of his science will be secure when Osler's in the development of his, is centuries forgotten? How many have heard of Emil Fisher? In his own group, chemists and biologists, he has for a generation sat on the highest tier of the seats of the mighty, and yet his place has been quite without the public ken. A supreme investigator who undertook the most fundamental and most difficult problems of his science, he carried on a labor which by its very nature has been inexplicable to the average man. To be sure the average man would not wish it explained to him, would resent it deeply if forced to listen to such dry stuff. But he is safe. No newspaper in the country would be competent to discuss it for him. The pathetic attempts of the daily press to keep up on the relatively simple subject of poison gas in the late war and the rude caricatures of chemical nomenclature which finally found their way to the proof reader and past him, merely serve to emphasize this point.

Let us see if, without being too technical, we can show how it was that Emil Fischer came to stand so high above the crowd. Forty-five years ago Fischer discovered phenyl hydrazine, an accomplishment which alone would have sufficed to give him some fame, but in the hands of its discoverer phenyl hydrazine became a tremendous weapon, a 42 centimeter gun, a whole park of them in fact, for a war on the ultimate nature of the carbohydrates. These last substances are of immeasurable importance, making up as they do the bulk of matter in the vegetable world, including the sugars, starches, wood and various intermediary bodies. With the different sugars, scores in number, into which all of these substances can be ultimately resolved, phenyl hydrazine yields characteristic crystalline precipitates, permitting relatively easy identification. Be it said, once and for all, however, that Fischer did not pack up his phenyl hydrazine and his polariscope and enter the sugar business, nor did his altruism lead him to desert theoretical fields and apply his trained mind to the production of cheap

sugar for the people. What Fischer was interested in was the composition, the structure of sugars, and to few men has it been given to penetrate the subject so deeply. Molecules of the sugars, like those of all substances, are composed of atoms which stand to each other in definite relations in space. The molecules, that is to say, the essential units of a certain group of sugars, all contain six atoms of carbon, twelve of hydrogen and six of oxygen, and yet the group includes several distinct substances because the arrangement of these atoms in space is different. For instance, one possible difference in arrangement is that in which the atoms of two molecules are so disposed that the three dimensional molecule of one is the mirror image of the other. When the likeness is so close the properties are identical, except for one feature. A ray of light which has been "polarized" by passing through a Nicol prism is bent to the right by one form, by the other to the left. With greater variation in the arrangement greater differences in chemical properties are noted. Abstruse matter this, and all theory, for no piling up of lenses has ever been sufficient to enable man to gain a faint glimpse of one of these hypothetical molecules. Yet the theory stands, and by virtue of the enormous number of predictions made upon its basis which were later realized by experiment. And to Fischer, using the sugars, is due much of the credit for the establishment of this, the so called Van't Hoff and LeBel hypothesis.

The study of sugars led him to the substances that in nature act upon them, the enzymes or ferments, substances like the diastase which acts upon starch converting it into glucose. That enzymes are specific in their action had long been known, but it remained for Fischer to demonstrate how high that degree of specificity is. To one of a pair of extremely closely related substances, differing only in a slight variation in the arrangement of their atoms in space, a given enzyme is neutral, while acting readily upon the other. A slight change in the latter renders it, too, insusceptible. The proof of this led Fischer to the conclusion that enzymes act upon their substrates through exact spacial approximations, his famous key and lock analogy.

So much to show the nature of Fischer's work, to indicate the type of mind of the man. It was by no means the only, or even the largest, problem this brilliant and versatile chemist undertook. In another class of compounds, the proteins, was a chaos which seemed of inconceivable complexity until Fischer pointed the way through. Proteins are peculiarly biological; without them there would be no life, and differences in protein are probably ultimately responsible for differences in living forms, inasmuch as protein must carry the hereditary characteristics. They are found in greatest bulk in the animal kingdom, though not confined to it, and include such well known substances as egg white, the casein of milk, and flesh of all forms. In the analysis

of these proteins, involving breaking them down and identifying the products, Fischer played a great part, his greatest contribution being the development of a method which enabled others to expedite the solution of the colossal problem. Difficult as the analysis has been Fischer was at the time of his death in a fair way of accomplishing the reverse, the synthesis or reconstruction of a highly complex protein from its split products, a tremendous conquest of the world of the unknown.

One more glimpse and we shall leave the subject of Fischer's work and place our label on the man. Combined with certain proteins in that mysterious portion of the living cell which apparently governs the latter in its chief actions, the nucleus, is a substance called nucleic acid, characterized in part by the presence of certain bases, the purines. The familiar uric acid is a member of this group. Fischer, working on uric acid and the related substance, caffeine, synthesized both, and not only them but all other members of the group. It was a work of prime importance chemically and brings up for our consideration a special point. Fischer commercialized his artificial synthesis of caffeine, that substance both praised and reviled, and made many thousands of dollars. The emphasis placed upon this associated his name in many minds, especially those of medical men, with the substance caffeine, and in superficial biographical treatment it has been customary to list its synthesis along with his other great accomplishments and on the same plane. As a matter of fact it must be thought of as purely by the way. Beyond question what really counted in Fischer's mind was not the synthesis of this isolated substance but the unshrouding of the relations of that whole group of compounds of which caffeine was but an ordinary member, making the previously confused subject as clear as the light of day.

Fischer was an aristocrat in scientific work if there ever was one. No man can explain this devotion to his science. We can perhaps say that the ability created the desire, but most men work for rewards, and what was Fischer's? Fischer made money, but no sum of money could be adequate pay for the superhuman accomplishments of the man, nor did he make a tithe of what he might have made had he tried. He saw himself in the front rank of scientific men, but the contemplation of that spectacle must have palled upon his cold judgment. The only thing that remains is the thing itself. Pushing back the horizon of knowledge was its own reward.

Scores of other pairs might be cited to illustrate the grouping over and over again. A fascinating book might be written by plagiarizing a method from Plutarch and setting down side by side the biographies of great scientific men, laboring on similar lines, devoted to different points of view. We could thus pair off contemporaries, and going

closer, warm friends, and sometimes master and pupil. What could be more characteristic than the distinction in the attitude of Darwin and his brilliant spokesman, Huxley? On the one hand, we have the quiet naturalist of Down turning over in his mind for twenty years observations made on the voyage of the Beagle, and the culmination of that reflection in the scientific torpedo of the nineteenth century, *The Origin of Species*. And on the other, stands the rugged Huxley, self-appointed champion for truth, the most lucid scientific writer of the day, meeting all comers in defense of the theory of evolution, nay, going much further, carrying war into the enemy's country, extending his campaign beyond the field of biology and evolution and, through the medium of the public press, hammering into public consciousness the scientific method in general. In Darwin's own words in his autobiography we have this; "I think I can say with truth, though I cared in the highest degree for the approbation of such men as Lyell and Hooker, who were my friends, I did not care much about the general public. I do not mean to say that a favorable review or a large sale of my books did not please me greatly, but the pleasure was a fleeting one, and I am sure that I have never turned one inch out of my way to gain fame." He must have been regardless of public approbation who spent eight weary years on the Cirripedia, describing all known living species, and publishing two quartos on the extinct species, and who passed from the *Origin of Species* to a book on the "Fertilization of Orchids." But Huxley was different. Brilliant investigator that he was himself in the field of pure science, he cared more for something else. The education of the masses was the supreme thing. He fought to give the people the truth at a time when they did not want it, and how he came up from the bottom is appreciated by few of the succeeding generation who take his victory for granted.

We might confuse the issue a little and pair off Sir Humphry Davy and his pupil, the immortal Faraday, perhaps the most lovable man science has ever produced, and, if we except Pasteur, the favorite of all biographers, Faraday, who never knew what it was to have a decent income, and presented to the world a set of scientific experiments the cash value of which to mankind was estimated by Brailsford Robertson some years ago at seventy five billions of dollars. For to Faraday we owe the motor and the dynamo.

Which was Faraday? The aristocrat surely, we say when we recall that he repeatedly dropped his investigations when they neared the point of marketable value. But he never lost sight of the latter. "I had rather," he said, "been desirous of discovering new facts and new relations dependent on magneto-electric induction than of exalting the force of those already obtained, being assured that the latter would find their full development hereafter." And when asked of the possible

utility of some of his discoveries he was wont to reply in the words of Franklin, "What is the use of a baby?" And it is on record too that in dispute over the priority of certain scientific discoveries he stood resolutely on his rights on more than one occasion.

And Davy, baronet and pet of society, aristocrat in the common acceptance of the term—which was he? "A philosopher" he was in the old terminology, and the "philosophers" were mostly aristocrats in science. His fame rests chiefly on his discoveries in electro-chemistry, but we can not forget the ten years of lecturing in the cause of agriculture and his own experiments for its promotion. And there is the deliberate and successful attempt to produce a safety lamp for miners, followed by the presentation to him of a set of plate worth two thousand pounds by the coal owners of the Tyne and Wear in testimony of their appreciation of the benefit thus conferred. And we know that his last great scientific endeavor was an effort based on exact deduction from the laws of electro-chemistry to protect the copper sheating of vessels from the corrosive action of sea water. Vain and selfish he may have been, but he must have had the interest of the people at heart, and so we can place that to his credit against his oft cited jealousy and ill treatment of his rising, more brilliant pupil, Faraday.

Probably the greatest scientific democrat in history is Louis Pasteur. No more patent testimony of public affection for a scientific man has ever been given than that expressed in the recent French plebiscite on the greatest man of the nation, which went easily to Pasteur with Sadi-Carnot and the great Corsican running second and third. And yet, as we have defined the term, Pasteur began his researches as one of the aristocrats; it was his brilliant success in a field of pure science which laid the foundation and directed the way for his later, more famous, investigations on the etiology of disease. It was in the course of his highly technical work on the optical rotation of the salts of tartaric acid that he discovered the fact that of its isomers one form is destroyed by fermentation, and the other not. These isomers, like the sugars described above, differ from each other simply in the arrangement of the same atoms in space. He thus anticipated by many years Fischer's classic work on enzymes. But in their application of the facts thus secured is strikingly emphasized the wide divergence in the point of view of the two men. Fischer's work on ferments constantly led back to the theory of sugar structure. With Pasteur's successful solution of his problem he turned the page and with new interest in fermenting bacteria entered upon that lifelong endeavor to thwart the action of pernicious microorganisms that has made him one of the greatest benefactors of mankind.

How he passed first to the relief of stricken industry, adopting means, based on his discoveries in bacteriology, for the cure of

"diseases" of beer and wine, and of the fatal silkworm disease, and thence to the extermination of those plagues, fowl cholera and anthrax, which were wiping out the flocks and herds of France, saving to the country in a matter of months the equivalent of the Franco-Prussian war debt, and thence to preventive vaccination in man, has been the theme of a score of biographies and many an inspiring address. The life of this non-medical man is held up as a shining example by the most intolerant of professions for the guidance of its students and future fellow physicians.

Commenting on aims in scientific research the famous British chemist, Roscoe, chose a text from Pasteur to bear him out in his contention that although it would be foolish and short-sighted to decry the pursuit of any form of scientific study because it was as yet far removed from practical application to the wants of man, yet discoveries which tend to diminish the ills that flesh of man or beast is heir to, deservedly create a more general interest than those having no direct bearing on the welfare of the race. In the French hero's simple words, "There is no greater charm than to make new discoveries, but the pleasure of the investigator is more than doubled when he sees they find direct application in practical life."

The same year that Pasteur graduated from the Ecole Normale in Paris a young German physician, but a few months older, read, before the physical society of Berlin, one of the two epoch-making scientific contributions of the century, "Ueber die Erhaltung der Kraft" rivaled only by the *Origin of Species* in its effect upon thought. The notion of the Conservation of Energy may not have originated in the precocious intellect of Helmholtz, for Newton, DesCartes, Leibnitz, Lavoisier, Mayer, Colding and Joule had more than touched it, but it surely crystallized there. It remained for a physician to desert his chosen field for a theoretical one and establish the fact that energy, although it may be transformed in kind, is indestructible, and the total quantity in the universe is constant. The physiologist was also a mathematician of the first order.

Perhaps the most frequently cited achievement of Helmholtz is his invention of the ophthalmoscope, that familiar combination of mirror and lenses used in examination of the interior of the eye. How did he come to devise it? As a matter of fact it took its origin in a simple desire to exhibit a physiological phenomenon to his students. It had long been known that light could be reflected from the back of an animal's eye, but no one had yet been able to put his own eye in such a position as to have reflected directly back to it light from the illuminated eye in concentrated form. Helmholtz, by the proper disposition of mirrors, involving a knowledge of optics and the anatomy of the eye, accomplished this for the first time, and, eight days after

he conceived the desire to show it to his students, he was the first to see the living human retina.

While following the invention of the ophthalmoscope, Helmholtz was occupied for some years with physiological optics, it can not be said that it "set" his career as it might have done with another man, as for instance his invention of the stethoscope did with Laennec. The latter putting a paper cylinder to a consumptive girl's chest discovered that through it he could hear the sounds of moisture vastly better than by direct application of the ear. Here was a method, and the young clinician devoted the rest of his own all too short consumptive's life to diseases of the chest. Helmholtz turned the so called practical application of his ophthalmoscope over to the clinicians and busied himself with the discovery of new facts and explanation of old, quite regardless of their direct application to the ills of man. The physics was the more attractive field than the pathology, and to the end of his life he gravitated more and more from the latter toward the former, until the boy of twenty-eight, who started out as a professor of physiology and pathology at Königsberg, became at fifty the dominating figure of the time in physical science as professor of physics in Berlin. While he was one of the masters of medicine, his contributions were toward theory and not practise, his name being associated in the science chiefly with the explanation of vision and hearing and the theory of color and tone. That immeasurable practical use of his discoveries is being made goes without saying. But it is indeed a fortunate thing for mankind that the superb intellect of Helmholtz was not turned into the superficial channels of practical usage but was left free to explore the unknown depths below.

In later years his trend of thought took him more into the field of dynamics and electro-dynamics, bringing him back to the direct course on which he started forty years before with his immortal essay on the Conservation of Energy. His intellectual goal was never a democratic one. He felt it his duty as a disciple of science to ascertain truth for its own sake, and no man more strongly decried the pursuit of science merely for the practical results. His clear exposition of the principles of the transformation of energy furnishes the index of his character, and, whatever the practical applications of the principles thus enunciated may be, we can not avoid the impression of something essentially aristocratic in a young man of twenty-six killing for all time with one blow, the idea of a machine for perpetual motion.

Obviously the points of view of Pasteur and Helmholtz were fairly far apart. This does not mean that the one was consistently democratic and the other at all times aristocratic in the sense defined above, throughout their long lives of scientific research. Many times the rôles were reversed. Helmholtz contributed a practical remedy for

nasal catarrh, and Pasteur evolved a theory of the essential nature of fermentation. But the dominant note of each was as given above. Pasteur burnt himself out in the effort to bring relief to a mankind patently suffering before his eyes. Helmholtz consumed his candle more slowly, pursuing the even tenor of his way without committing himself on his sympathies.

Undoubtedly the distinction is but vaguely general, and perspective may be needed to bring it out. Undoubtedly there are no pure types. Scientific men, goaded by poverty or other considerations, may and often do change the direction of their researches, like the rubber synthesist of "Marriage." The war brought out many a quiet man from purely academic life to construct a poison gas, or detect a submarine, or relieve a starving people. But most of these men have gone back. The will of the people was temporarily irresistible. But characters were not changed much. A certain group are altruistic from the start, and do not need to explain their motives. The other group are exclusive and do not try to explain theirs, except to each other. They isolate their intellectual lives to a certain extent, in all the pride of an aristocracy based on achievement rather than accident. The achievement is the increase of knowledge, and that is both goal and prize.