A LIFE OF PASTEUR.

The Manner of Man He Was, and the Results He Accomplished.*

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FEW names of purely scientific men are so widely known among people of all classes as that of Louis Pasteur; few men have been able to accomplish so much to increase material prosperity and at the same time be the means of warding off dangerous and widely fatal diseases from animals and men, and he stands almost, if not quite, alone among discoverers of great and revolutionizing facts and principles in nature—in the honor and fame which came to him during his lifetime. All this constitutes him a phenomenal personality and leads us to inquire what manner of man he was and what were the works which have made him so conspicuous and admirable, and these inquiries are most charmingly and for the most part satisfactorily answered in the two attractive volumes before us, written by his son-in-law, René Vallery-Radot.

Pasteur did not spring from stock in which brains and mind had been cultivated by education through generations of learned and distinguished men; on the contrary Claude Etienne, Louis Pasteur's great-grandfather, was attached to the estate of François, Count of Udressier as a serf, as his ancesters had long been to the same succession of Counts; but he was ambitious, and by deed drawn up before a Royal Notary, this Count of Udressier consented by "special grace" to free Claude Etienne Pasteur, a tanner, his serf, and his unborn posterity; and four gold pieces of twenty-four livres each were then and there paid to the Count by the said Pasteur as a consideration. His son, Jean Henri, was the father of Jean Joseph, who in turn became the father of Louis Pasteur, the well-known scientist.

Pasteur's father was uneducated, except that he could read and write, and he followed the tanner's trade as his father and grandfather before him had done. He was drawn as a conscript in 1811, became a Sergeant Major in the noted Third Regiment, served with distinction, received the Cross of the Legion of Honor from Napoleon, and after the Emperor's first banishment he sorrowfully returned to his trade. He married Jeanne Etiennette Roqui, and the biographer makes this significant note: "They seemed made for each other * * * he was reserved, almost secretive, with a slow and careful mind. * * * She was active, full of imagination and ready enthusiasm." They settled down in the Rue des Tanneurs at Dôle, and there in a small room in their humble home, on Friday, Dec. 27, 1822, Louis Pasteur, their third child, was born. Such was the ancestry of this remarkable man.

As a boy Pasteur was thoughtful, studious, and diligent, artistic in temperament, but not brilliant in any particular direction, unless in drawing pictures with colored chalks, and especially portraits, of which he accumulated an extensive gallery, embracing portraits of Notables around Arbois, whither the family had moved from Dôle. His father had high ideals regarding his son's future, and he himself studied assiduously in order that he might be able to appreciate him and also guide him in his studies. Learned men of the town did not find it unprofitable often to spend an evening with the ex-Sergeant Major and his family. It is further noted that he seldom talked of himself or his exploits; always dressed carefully on Sundays, in his half military frockcoat decorated with the showy ribbon of the Cross of the Legion of Honor, and that he never entered a café. Such were some of the influences and environments of Pasteur's boyhood.

His systematic education was commenced at Arbois College and was continued at Besançon, a neighboring college where he could prepare for the "Ecole Normale." Here he received his degree of Bachelier ès Lettres, and later, in 1842, when he was twenty years of age, that of Bachelier ès Sciences; and here he established a reputation for industry, integrity, and fair, though by no means brilliant scholarship, but the letters he wrote, the companions he chose, and the books he loved all bear witness to the nobility of his character.

At the end of the school year of 1843 Pasteur received honorable mention in several studies, a first prize in physics, and was admitted to the Ecole Nor-

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male of France, fourth on the list in order of merit.

The life work of Pasteur may be examined under five chief divisions, namely, the study of crystals, of ferments, the silkworm disease, anthrax or charbon, and of hydrophobia.

Of these subjects the study of crystallization is to the general reader the least interesting, and so far the least productive of his works, and yet as an introduction to his more widely known labors, it should not be altogether omitted in this hasty review. In the midst of Pasteur's study of the subject, a note from the German chemist, Mitcherlich, was communicated to the Academy of Sciences to this effect. The paratartrate and tartrate of soda and ammonia have the same chemical composition, the same crystalline form, angles, specific weight, refraction, and inclination of the optic axes, but dissolved in water, the tartrate causes the plane of polarized light to rotate—the paratartrate does not. Are these two crystalline substances, apparently identical, but producing different effects, really identical? And if not, in what do they differ? Pasteur, who had now attained special skill in laboratory work of this kind, took up the study of this problem with enthusiasm, and first with regard to the symmetry or dissymmetry of crystals. A cube, for instance, has a plane of symmetry; divided through that plane, the part on the right of that division is exactly the same as that upon the left, and the crystal placed before a mirror presents an image upon which the object itself can be exactly superposed. So of the octahedron—the form presented by the diamond, which has several such planes. In the rock crystal there is no such plane of division, but however it is divided there will be a difference in the two parts. Applying this fact to the crystalline forms of tartaric acid and its compounds, he found they had no plane of symmetry; but Pasteur noticed what Mitcherlich and the others who had studied the subject had failed to observe, namely, that the crystals of the tartrates had facets or little faces—very minute—upon them, and furthermore, that these facets existed upon only half of the edges of similar angles, constituting what is known as a hemihedral form, and also constituting the crystal as a whole dissymmetrical. This was the form of crystal which caused a deviation to the right in the plane of polarization; and Pasteur at once hastened to the conclusion that the crystals of the paratartrate which caused no deviation would be without the facets. Examination showed that he was mistaken; the facets were in evidence there as well as in the tartrates, but what was most curious was that the little faces on some crystals were turned to the right as in the tartrates, and others to the left. Here at least was a structural difference. How did that difference affect the plane of polarization? He separated the crystals —those whose facets turned to the right from those whose facets turned to the left—and on testing the solution of each set of crystals separately he found that the solution formed of crystals whose facets turned to the right caused a deviation of the plane of polarization to the right, while that formed from crystals whose facets turned to the left caused a deviation to the left.

Previous to 1855 the process of fermentation was simply referred to by chemists as strange and obscure. Cagniard-Latour, studying the ferment of beer called yeast, had observed that "that ferment was composed of cells susceptible of reproduction by a sort of budding." Schwann also had made similar observations, but it seemed only an isolated fact, a curious circumstance connected with beer brewing, and without any general significance, and a mysterious catalytic force was predicted by chemists to cover their inability to explain the process of fermentation. Pasteur had already studied the process of lactic acid fermentation in sour milk, and had found the little organisms which accompany it; he now found that a solution of tartrate of ammonia mixed with albuminous matter, perfectly clear at first, soon became turbid, and that the turbidity was due to miscroscopic organisms which somehow found in the solution their proper aliment; and he recognized these little organisms as a living ferment. It was a bold conclusion and in direct opposition to the dicta of the then masters in chemistry. Taking this conclusion for a starting point, he soon proved that the ferment of lactic acid was one kind of an organism, that of butyric acid another kind, and the yeast plant or torula was still another; and still further, that the capacity of these organisms to act as a ferment depended upon their power to live without air, and to obtain their nourishment by robbing the organic substances with which they were shut up of the elements necessary for their life and growth.

The yeast plant fulfilled these conditions—it flourished well in contact with the air, but it acted as a ferment only when shut off from contact with the atmosphere, as in the brewing vat, where the sides of the vat and a thick layer of carbonic acid gas above it completely isolated it from the atmosphere, and compelled it to wrest from the malt the oxygen necessary for its growth and reproduction. So, after much contention and opposition, the process of fermentation was scientifically demonstrated as dependent upon living organisms.

At this time there was much complaint among the brewers that for some inexplicable cause certain brews of beer proved acid, ill smelling, bad in flavor, and often entirely worthless, in consequence of which the brewers were suffering great loss. Pasteur found by microscopic examinations that all these spoiled beers were the product of other and harmful ferments mingled with the torula or pure brewer's yeast. This fact once demonstrated, all that was necessary was the examination of the yeast to be used in any given case, and if foreign ferments of any kind were found the yeast was rejected, and only that used which was shown to contain no organisms but the proper yeast plant. In this way the whole trouble was remedied and the great loss from spoiled beer was prevented.

Having established the fact of the existence of, and the rôle played by, vegetable ferments in the manufacture of beer, Pasteur, in 1864, turned his attention to the diseases of wines, which had already caused a great falling off in the export of French wines on account of their liability to change and deteriorate. He examined the different kinds of spoiled wines—acid wines, bitter, "ropy," and sour wines—and found all these diseases due to the presence and multiplication of different kinds of microscopic vegetations. In his view, the cure consisted in opposing the development of these parasitic vegetations, and, after various fruitless endeavors to destroy the organisms without spoiling the wine, he at length found that all that was necessary was to keep the wine for a few minutes at a temperature of 122 degrees Fahrenheit—far below the boiling point—by which process the vitality of the obnoxious germs was destroyed without in any way impairing the quality or flavor of the wine. Immediately experiments on a large scale were carried out with perfect success. Such was the origin of the process now known all over the world as Pasteurization—a process which restored to France her prestige for the production and export of fine wines, and is now useful in so many different ways.

It was while Pasteur was pursuing his studies on fermentation that he was called upon by the Minister of Agriculture to investigate the silkworm disease, generally known as pébrine, an account of the pepperlike spots which appeared on the diseased worms.

Pasteur commenced his investigations in Alais in June, 1865. He had never handled a silkworm up to that time. He found the Alasians utterly discouraged, believing that nothing could conquer the pébrine, and that their industry was ruined. Pasteur was not discouraged. He at once submitted the corpuscles or pepper spots of the diseased worms to careful microscopic examination, also the eggs, the chrysalis, and the moth; and after carefully studying the various stages of development through many months he found that the only means of securing healthy eggs and healthy worms was to make use only of eggs produced from healthy moths. The problem now was to secure moths that were not already infected. In examining hundreds of moths he found only two or three pairs that were healthy. A few were brought to him from a neighboring province, and the seed from these, after patient waiting, was found to be healthy. From this seed healthy worms, perfect cocoons, and again the healthy chrysalis and moths were produced. Pasteur had conquered, and the silk industry of France was saved from extinction.

In 1877 a new field of investigation and usefulness was opened up to him. The cattle, sheep, and horses of France were being destroyed by a disease—a plague, we might say—known as anthrax, charbon, or splenic fever. Fifteen, twenty-five, and on some farms fifty per cent. of both cattle and sheep died of the dread disease, and the cattle and sheep raising industry was threatened with ruin.

Davaine in France, and Koch in Germany had already found minute bacteria in the blood of the diseased animals, and also that animals inoculated with this blood died of anthrax, but no practical results had been obtained. Pasteur now attacked the disease as he had already done the diseases of beer, wine and the silkworm. He found that not only the blood itself and the first culture, as shown by Koch, would prove fatal when injected into the tissues of healthy animals, but that these cultures, carried on ten, twenty, even forty removes from the original drop of blood were just as active and fatal as the blood directly from the infected animal. So it was established that it was the microbe—a living organism—that caused the disease, and was the medium of transmitting the disease from one animal to another, but the remedy was still lacking.

While these studies were being pursued a new microbe came up for observation —the microbe of chicken cholera. Pasteur pursued the same painstaking methods with this as with other microscopic germs of disease. The proper culture medium was difficult to find, but it proved to be the broth of chicken gristle. The virulence of the microbe was such that the smallest drop of a recent culture, no matter how many times removed from the original drop of blood, placed on the food given to a chicken quickly proved fatal.

It was now that a most important discovery was made. When the ordinary culture was used, the virulence always remained the same—the fowl experimented upon died of the cholera—but when some hens were inoculated with a culture that had stood exposed to the air for several weeks, they became slightly ill, and then perfectly recovered. These same hens, after their recovery, were inoculated with fresh culture and they were found to be immune; the most virulent microbes had no effect, while healthy hens not so treated, inoculated with the same culture, speedily died. What could have diminished or attenuated the activity of the microbes in the old culture? Experiments showed that it was simply exposure to the oxygen of the air. Trials were now freely made, and all the fowls inoculated with the virus attenuated by keeping, recovered after scarcely noticeable illness, and after this treatment the most virulent cultures had no effect. A preventive vaccine for chicken cholera had been found. From this point Pasteur set about finding a way of attenuating the virus of anthrax so as by vaccination to render cattle, sheep, and horses immune.

It was found that with chicken broth as a culture medium, kept at a temperature of 117 degrees Fahrenheit, the microbes of anthrax could not be cultivated, while at a temperature of 110 degrees they could easily be cultivated, but no spores appeared. Taking this sporeless culture and using it after ten or fifteen days' exposure to the air, it behaved exactly as the attenuated cultures did in chicken cholera.

Vaccinations for anthrax were now carried out on an extensive scale, both upon cattle and sheep, and with perfect success. The vaccinated animals were rendered immune to the most virulent cultures, while an equal number of cattle or sheep unvaccinated, treated with the same virulent culture, invariably died of anthrax. The demonstration was complete, and vaccination against anthrax became general.

These great industries had now been saved from ruin by Pasteur's discoveries—the brewing and wine making industries, silk manufacturing, and the cattle and sheep raising interests. All France now delighted to extol the man who had done so much for its prosperity and honor. Places were named for him in three Continents; medals were presented, tablets erected, honorary titles were conferred, and a pension of 25,000 francs awarded to him by the Government, to revert to his widow and children. The economic value of his discoveries can hardly be computed. Huxley estimated it as equal to the whole of the enormous indemnity paid by France to Germany in 1870, and some have added to that the whole cost of the French army during the war. But all this was only a part of Pasteur's achievements. His discoveries led directly to the establishment of the germ theory of disease—a theory or rather a doctrine which has revolutionized both surgery and the medical treatment of disease. It has already saved the lives of thousands, nay, millions of patients, especially those submitting to operative surgery, and in midwifery, and it has rendered possible and almost free from danger operations which before the time of Pasteur and Lister were deemed impracticable.

Even while carrying on these Herculean labors Pasteur took up the subject of hydrophobia, or rabies, and established prophylactic inoculations, which, in his hands, were most undoubtedly successful, and which, notwithstanding the present skepticism of many physicians, may yet prove a blessing to mankind.

M. Radot's book is like an entertaining romance, a romance without fiction. It is for such romances that Science is now constantly furnishing material, and it is such that in the better time coming will share the honors with the now much-praised pure literature.

In addition to Pasteur's scientific labors, by no means all of which have been here indicated, it would be a pleasure to dwell upon the personal element in his career—his quaint love and marriage episode, his domestic relations, his broad religious sentiment and philosophy, his patience and faith under the loss of children whom he dearly loved, and in his own mid-life almost fatal illness, his mildness and lovableness among friends, but his terrific force when either what he considered established truth in science or his beloved France was attacked or maligned—all this and much more must be passed by in this hasty survey and left to be enjoyed by the fortunate readers of one of the most delightful and helpful books that has lately appeared.

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