don, and was also Honorary Fellow of the Royal Agricultural Society of Great Britain. He was for two years President of the Academy of Science of St. Louis, being the youngest member so honored. He was founder, and for two terms President, of the Entomological Society of Washington, one of the founders of the Biological Society of that city, and an honorary member of the horticultural societies of Illinois, Iowa, Kansas and Missouri. The Kansas State Agricultural College gave him the degree of A. M., and the Missouri State University in 1873 conferred upon him the degree of Ph. D. He was lecturer on entomology at Cornell University and at other institutions.

A. S. PACKARD.
BROWN UNIVERSITY.

BIOGRAPHICAL NOTES ON LOUIS PASTEUR.

A DISTINGUISHED chemist, Dean of the Bussey Institution, Harvard University, Francis H. Storer, said a few days before the death of Pasteur, "Pasteur is the greatest genius produced in this century," and, he added, "He is a chemist."

As it has been my good fortune to be intimate with Pasteur since our college days, living in the same room, as *chum*, during several years, and keeping up our intimacy, notwithstanding my wandering life in both hemispheres, a few words of remembrance may be acceptable. I have before me at this moment a bundle of his letters, the first one dated 10 June, 1845, and the last dated 14 December, 1887, with letters after that date from his wife to keep me 'au courant' of his failing health; all his memoirs and papers, bound in 7 volumes, each one with a dedication in his handwriting, such as, 'A mon ami Jules Marcou, souvenir affectueux, L. Pasteur;' and three portraits, taken in 1863, 1868 and 1891, all with dedication, as, "A mon ancien et bon camarade Jules Marcou, souvenir affectueux, L. Pasteur." So I am pretty well able to give exact information on his life and character.

Born at Dole, Jura, 27 December, 1822, in the 'rue des Tanneurs, 43,' (Tanners street), where a marble table was erected the 19th of July, 1883, with the inscription 'Ici est né Louis Pasteur, le 27 Décembre, 1822;' Pasteur was removed a few weeks later to a small tannery on 'La Vache' creek, between the village of Marnoz and the Chateau de St. Michel, near Salins, Jura, and remained there until the fall of 1829; when his father finally took a tannery on 'La Cuisance' creek, at the western outlet of the little town of Arbois, Jura, where Pasteur was educated and kept his home until his death. The family originally came from Salins, Jura, where during the eighteenth century they were well known as tanners. His father was born there, and his mother, *née* Roqui, at the village of Marnoz, Canton of Salins. Jean Joseph Pasteur, born in 1790, did not received a classical education; he took the profession of his family, and was a journeyman tanner at Salins, when the conscription took him in 1811, and sent him as a private in a regiment of infantry, in Spain. There by his bravery, good conduct and capacity, he was rapidly raised to the rank of sergeant-major, and decorated Knight of the Legion of Honor, not an easy position to reach in the French armies scattered all over Spain, far from Napoleon and consequently much neglected as regard promotion and decoration of the Legion of Honor. Dismissed from military service in 1815, Pasteur returned to Salins, and resumed his work as a tanner. He was a good looking and very intelligent man. If he had received an education he would have made his mark. Knowing how important education was, he did all in his power to do to give his son an opportunity. First, Louis Pasteur became a pupil at the small college of Arbois, from 1831 to 1839, then he was sent as an 'interne' to the

College Royal of Besançon, where he stayed from 1839 until 1842. There he took in 1840 the title of Master of Arts, or 'Bachelier,' and prepared for the 'Ecole normale Supérieure.' Then he did not show any aptitude for chemistry; it is true that the old professor of chemistry and physics was a old fashioned savant, extremely diffuse in his lectures, and Pasteur was not attracted by the lessons; so much so, that it was I, who have but little capacity for the work, who was chosen as the assistant by the professor. There was no pay, and the professor chose for his assistant the pupil that he liked best, provided he was an 'interne,' in order to have him within reach one or two hours before his lecture to prepare the experiments and the instruments. Then Pasteur was not what is called a brillant student, but he was a good one, standing second in our class, myself being No. 3. As a great privilege, the provisor of the college gave to Pasteur and me one room, where we worked and slept, instead of being obliged to be with the other pupils in the 'Salle d'Etudes,' and in a great dormitory. Our room was only whitewashed, and our furniture most elementary. What Pasteur did, at once, was to make a good fresco picture, on the side of the wall above the blackboard. That picture, well executed considering the time and the youth of the painter, represented a scene of Childe Harold of Byron. Pasteur had a remarkable disposition for artistic work, and we all thought then that he would become an artist; so much so that we called him, as a nickname, 'The Artist.' And the title stuck to him many years after his college life. I may add that he drew my portrait in colored pencil, at that time a good likeness, when I was eighteen years old. I posses it still, it is signed 'P.(asteur) L.(udovicus) del (delineavit), 1842.'

From 1843 to 1846 Pasteur was a pupil of the *Ecole Normale Supérieure*, following the lectures of the Sorbonne, as is the custom. The third year he chose the 'Sciences physiques et chimiques,' and graduated an 'Agrégé' for those sciences in August, 1846. It was during his stay at the Normal School that Pasteur showed his taste for chemistry. He was in perfect rapture at the end of each lecture on chemistry by the two ordinary professors of that science then at la Sorbonne, Messrs. Balard and Jean Baptiste Dumas. To be sure Pasteur admired the talent of exposition of Dumas; but was a little shocked by his way of dressing too much like a scientific dandy, by his too studied posture and by his affectation. It was not so with Balard, who was entirely sympathetic to the modest tastes of Pasteur. But what attracted most of his attention was neither Balard nor Dumas, but their assistant, then a rather old man, M. Barruel. As a practical chemist, a skilful manipulator, Barruel had few equals, if any; all the operations always succeeded with such precision, exactness and at the right time that Pasteur was absolutely astounded and in perfect rapture. I have seen him, at the end of some of those lectures, with his eyes filled with tears, ready to cry; so much was he moved by what he had heard and seen.

At the end of 1846 Pasteur was appointed assistant to Professor Balard, who was 'Maître des conférences de chimie,' at the Normal School; a new post, poorly paid and rather difficult to obtain from the French government, which then was sparing in regard to new scientific expenditures. All that Pasteur wanted was to stay in Paris, no matter how poorly he was paid. At that time the Normal School was on the point of being removed from the old and inadequate building of the annex of the Louis-le-Grand College, to a large and even beautiful mansion built especially for that purpose in the rue d'Ulm. The school was not removed, however, until September,

1847; but the two laboratories for chemistry and physics were ready for occupancy in 1846, and Pasteur, who had charge of the Chemical one, began at once the installation, being with Bertin, the physicist, the two first inhabitants of the new Normal School mansion. For the time the laboratory was excellent, even luxurious, and from the first day, with the help of a young man named Thomas, who acted as servant, and has since become a very able professional chemist, Pasteur became that extraordinary manipulator, unequalled in the history of chemistry for exactness, sharp and delicate observations.

The first work of Pasteur is on crystallography and rotatory polarization; and to the surprise of Biot and Mitscherlich he created a new chapter of chemical crystallography, by his discovery in regard to the tartrate crystals. Then he worked on dimorphism. During the year and a half that Pasteur passed as chemical assistant at the Normal School incessant laboratory work took all his time; often he was at the laboratory at 6 a. m., and at 12 o'clock p. m. he was still studying, in his room, chemical books borrowed from the Library.

We used then to take our meals together; hardly speaking to one another at breakfast, so full we were, both of us, of our work. It was only at dinner time that we exchanged our thoughts; walking after dinner first to my room, rue d'Enfer, 51; Pasteur and I, would get up the four stories, and pass one or two hours talking on scientific subjects, travels, etc., often two or three other friends joined us, such as Quintino Sella, the mineralogist and Italian statesman; Bartholomeo Gastaldi, the geologist; A. Pomel, the paleontologist and geologist, and Oscar Fraas, the geologist. Then Pasteur always pursuing an idea, would take French leave and go to his room in the rue d'Ulm. We never went into society, or to theatres, or to 'cafés;' taking now and then a walk, in the Luxembourg Garden; in fact our lives were hermit lives, entirely devoted to science and friendship.

It was during those two years, October, 1846, to March, 1848, that Pasteur learned to be such an expert in chemical laboratory work; and he owed a great deal to the private teaching of old Barruel, the chemical assistant at la Sorbonne. But he was also a rare and unique pupil, extremely skillful with his hands, with near-sighted eyes, which scrutinized everything, and let pass nothing without seeing what it was, extremely patient, never tired when at work, and with those great qualities not an absent minded man, always being on the contrary wide-awake.

In May, 1848, Pasteur, who had taken his degree of doctor of physical and chemical sciences at the end of 1846, was appointed professor of physics and chemistry at the lyceum of Dijon, where he stayed only three months, being called to the faculty of science at Strasburg, first as substitute, and three years later as full professor.

During the five years he passed at Strasburg, from October, 1848, to August, 1854, Pasteur studied the correlations between dissymetry and the deviation of polarized light in minerals. He proved that the molecular dissymetry is the only sharp demarcation existing between the chemistry of 'la nature morte' and the chemistry of 'la nature vivante.' It was during his stay at Strasburg that Pasteur married Miss Mary Anne Laurent, daughter of the rector of the academy at Strasburg. It is said that he was working so steadily at an experiment in his laboratory, the morning of his his wedding, that some friend was obliged to go there and bring him up to be prepared for the ceremony. Never was a better match and a more harmonious couple.

In October, 1854, Pasteur removed to Lille, where he had been appointed dean of

the new faculty of science just created then by the French government. As soon as installed in his new position he began the work which has given him his world wide reputation—his study of the ferments. He was then thirty-two years of age, and had never studied physiology, anatomy or biology, and notwithstanding the difficulties inherent to such a change in the direction of his researches, leaving the physical and chemical molecular works, he turned abruptly to physiology, against the advices of his friends and patrons, Biot and Dumas.

Pasteur began his studies on ferments with milk, finding there bacteria so small that their diameter was only the thousand part of a millimetre. Then he took the transformation from wine into vinegar; when suddenly he was confronted by a very sharp opposition brought up by Félix A. Pouchet, of Rouen, on the question of spontaneous generation. Pasteur saw at once that the origin of microbes was not to be eluded any longer, and without hesitation he began a series of observations requiring the greatest care, ability and keen attention which had perhaps ever been given before in laboratories. Every scientific friend of Pasteur tried to dissuade him from such researches, except one, the great crystallographer, M. de Senarmont, who had an absolute confidence in the extraordinary ability of Pasteur as an experimentator. The great success achieved by Pasteur has put now to rest forever the question of spontaneous generation, which broke the first ring in the chain of the 'Origin of Species' of Darwin. It is curious that neither Darwin nor any of his followers had ever tried to oppose Pasteur; not but that opponents in England made, like Pouchet, objections and presented observations which seemed to break Pasteur's experiments; but little by little all opponents left the field, and John Tyndall did not hesitate to accept and uphold Pasteur's views.

The studies on wine, which followed closely those on vinegar, required a great deal more research, and the volume published by Pasteur: 'Etudes sur le vin, ses maladies etc' in 1866, is and will remain the standard work. The amount of money saved by Pasteur's method of treating diseased wine may be counted by millions and millions of francs; for it is used not only in France but in every wine growing country.

The French government, justly desirous to put an end, if possible, to a sort of pest among the silkworms which destroyed almost all the fortunes of the southern part of France devoted to that industry, asked Pasteur to go there and study the sickness of the silkworms. Dumas, the chemist, told the Emperor Napoleon III., "if any body can do anything about it, it is Pasteur!" At first Pasteur was unwilling to abandon his work on ferments, which had already given such great result; and it was only to the pressing solicitation of Dumas, who was from a district of Languedoc, most affected and almost totally ruined by the pest on silkworms, that Pasteur yielded at last. On taking leave of me, he said: "I do not know, what I am going to find; it is *la bouteille à l'encre*!"

Pasteur worked steadily during five years at the silkworms, with the splendid result of finding a practical way to stop the pest; and now the silk industry of France, Italy and other European countries engaged in producing silk is more prosperous than it ever was before the epidemic.

In the two volumes: 'Etudes sur la maladie des Vers à Soie,' 1870, Pasteur has given to the world all his researches and remedies. It is in Vol. 1, p. 99, that we read the following prophetic sentence, of which his subsequent discoveries have given such a splendid confirmation: 'Il est au pouvoir des hommes,' says he, 'de faire disparaître de la surface du globe les

maladies parasitaires, si, comme c'est ma conviction, la doctrine des générations spontanées est une chimère.'

Pasteur remained only three years at Lille, and in October, 1857, he removed to Paris, as director of the Scientific Section of the Normal School, taking his residence again rue d'Ulm, nine years after leaving it in 1848. This time he was finally settled in Paris. He knew well that the excessive centralization of France obliged a savant to be in Paris, if he wanted not only to be appreciated, but also to get sufficient help from the government for his researches. At first he had no laboratory, being obliged to build one at his own expense in the garret of the Normal School. By and by a vast and good laboratory was built, exclusively for his own use, in the yard directly on the left after entering the gate of the school. A marble slab has been lately placed against it, recalling that it was the Pasteur Laboratory. It was there that most of his discoveries in bacteriology were made.

In October, 1868, Pasteur was struck by a very strong attack of hemiplegy; during several days he was in constant danger of losing his life, and for months he was so infirm as to be unable to leave his bed or his room. Little by little, however, he recovered—a wonderful case of recovery. Paralyzed on the left side, his arm and leg kept visible marks of the paralytic stroke, and he looked always as a wounded man; but happily his mind was never affected, after the immediate danger was past. I remember one night, when I kept watch over him, his eyes—always very beautiful—were almost lighted up by happiness. "You are surprised to see me so contented; it is because I begin to feel that I shall get out of this terrible sickness; my head is full of thoughts because I have so much to do with the ferments!" His desire of prolonging his life was mainly in order to continue his works on bacteriology. What an infatigable worker! Being only forty-five years old, and having never abused anything but too hard work; Pasteur rallied, and was able to go again to Alais, in Languedoc to continue his observations on the silkworms. The next year he was in Italian Austria, at the villa Vicentina, near Trieste, carrying on his researches; when the news of the declaration of war between France and Prussia reached him. He started at once to come back, passing through southern Germany. What he saw in passing at Munich had made him anxious; and I remember a visit which he received at the beginning of August of General Favé, the commanding officer of the Polytechnic School. The general told him that the arms possessed by the French army were so much superior to those of the Germans that no fear was to be entertained as to the final result.

Pasteur received notice from Marechal Vaillant, a few days after his return, that the Emperor Napoleon was so satisfied with his work on the silkworms that he has just signed his nomination as a Senator. But the nomination was never printed in the *Journal Officiel*, and was left in the hurry of the departure on the desk of the Emperor; so Pasteur was only a Senator *in partibus*.

Pasteur was a very strong patriot; the defeat of the French armies went to his heart so strongly that he abandoned all work, and for the first time his laboratory was deserted. Having retired at his house at Arbois, he passed a most distressing winter, crying like a child at the reading of newspapers. When Franche-Comté was invaded he left Arbois to retire to Switzerland. Passing through Pontarlier he found there the retreating columns of Bourbaki's army in great confusion, and among them he met his only son, Jean Baptiste, a corporal of chasseurs.

As soon as he was able to recover his balance Pasteur went to Clermont-Ferrand,

in Auvergne, where his favorite pupil, M. Duclaux, was professor of chemistry, and there in his laboratory, during the Commune, Pasteur began his series of researches on the ferments of beer, which resulted in the publication, in 1876, of his magistral work, 'Etudes sur la Bière, ses maladies, etc.'

We have come now to the work, which has placed Pasteur at the head of the Philanthropists, as the greatest benefactor of humanity. First it was his discoveries of antiseptics, which, as Dr. Lister says in a letter to Pasteur, dated February, 1874, was suggested to him by the reading of his studies on the germs of putrefaction. It was not without hesitation that Pasteur became a physiologist, as he said often then, "I am neither a Doctor of Medicine nor a veterinary surgeon;" but good words to encourage him came from many masters of science, such as Claude Bernard, Rayer, Bouley, Paul Bert, Tyndall, Huxley, etc. In a letter dated February, 1876, Tyndall expresses his unbounded admiration for the researches of Pasteur, saying that "thanks to his works, medical sciences will soon get rid of empirical methods and be placed on true scientific bases."

The discovery of the bacteria of the anthrax conducted Pasteur to the sure cure of that terrible and disastrous sickness among sheep, oxen and horses, saving millions of francs to agriculturists and stock breeders; then came in succession the septicæmia, the cholera of chickens and hydrophobia. The last discovery is the one which made Pasteur so popular; persons bitten by mad dogs and mad wolves came from Russia, Germany, Austria-Hungary, England, Algeria, even America, to be inoculated and treated. At first Pasteur was very timid; and the first two of his patients, who died, notwithstanding his care, were very distressing to him; but medical colleagues encouraged him, saying that some cases are refractory to all sorts of medications, and the brilliant results of numerous cures, shown by careful statistics, soon put an end to his hesitations.

The cure of diphtheria, although not made by Pasteur, was inspired by him, and Dr. Roux followed closely all the directions and suggestions made to him by his illustrious master and teacher.

Pasteur met many opponents, for it is in human nature to oppose discoveries made against accepted theories, and savants occupying exalted position do not like to be interfered with. In Germany Liebig and Koch, in England Dr. Bastien, and in France Berthelot and Pouchet, made opposition not exempt from passion and jealousy. The attack of Berthelot, who published, six months after the death of Claude Bernard, a posthumous paper found in notes, rather incomplete and confused even, which if true was the inauguration of a new system of spontaneous generation among the ferments of grape wine, took Pasteur by surprise and was very painful to him, for he has always professed a great admiration for Claude Bernard, with whom he was in most intimate friendship. Without losing time, Pasteur started for Arbois and carried out delicate experiment, in one of his own vineyards, which after one year showed most conclusively the mistake of both Bernard and Berthelot. This discussion is printed in full, in 'Examen critique d'un écrit posthume de Claude Bernard sur la fermentation,' 1879.

Pasteur received more honor during his life than any other savants ever did, and he entered into immortality before his death. The honors bestowed on him were all well deserved; for not only did he orient a new medical science, surgery, the veterinary arts, the making of beer, wine and vinegar, but he always declined to take patents of any sort, notwithstanding most tempting offers of large sums of money

from speculators, saying that he was paid by the French government and that all his discoveries belonged to the public. As Huxley says: "The discoveries of Pasteur are sufficient alone, to have repaid all the tribute of war of five milliards of francs paid by France to Germany."

In our time, when money seems to be everything, and when we have the discouraging spectacle of competitions to get at great fortunes by all means, it is a great example to see a man refusing to be tempted and perfectly satisfied with a modest pension of 12,000 francs yearly, soon raised to 25,000 francs during his life, to be continued to his widow and afterwards equally divided between his two children. To be sure the honor is unique. His public funeral, also at the national expense, attended by the President of the French Republic, and followed by the mass of the population, without regard to parties, is another noble manifestation, unmixed with any discordant notes, from the humblest citizen, and even children, to his highest surviving contemporaries.

One more word, Pasteur's last creation was his Institut, rue Dutot, built by private subscriptions and sustained by rents from a yet too small capital, increased happily yearly by annual appropriations from the French budget. There the new roads he opened to science will continue to attract the attention of the scientific world, and discoveries will go on under his direction and methods. Pasteur was very anxious to place it on a sure and somewhat independent basis, and in the last letter he wrote me with his own hand, when already stricken with the ailment which terminated his life, he says:

"INSTITUT PASTEUR,
PARIS, le 14 décembre, 1887.

MON CHER MARCOU:

Je suis heureux des bonnes nouvelles que tu me donnes de ta santé. La mienne a été éprouvée dans ces derniers temps par une congestion qui m'a rendu la parole un peu difficile. Quoiqu'il en soit je suis, depuis quelques semaines, une hygiène de repos et de calme qui me réussit assez bien.

Tout va bien au laboratoire et l' Institut Pasteur, est presque terminé, moins l' aménagement intérieur. L' inauguration cependant n 'aura lieu qu' à la fin de l' été prochain et nous n'en prendrons possession qu'en Novembre, 1888. Ce sera grand et confortable et de bel aspect. La souscription a dépassé deux millions. Avec le legs récent de Madame Boucicaut (du *Bon Marché*) et un autre legs d'un négociant de Lyon, elle dépassera deux millions deux cent mille francs. Les constructions et l'achat du terrain atteindront douze cent mille francs et plus.

Nous avons donc besoin d'accroître encore beaucoup notre capital. J'ai confiance en de nouveaux legs.

Ah! si nous étions en Amérique, le pays aux généreuses et grandes initiatives!

Déjà nous rendons mille actions de grâces à la très digne Madame Boucicaut qui n 'a pas contribué à la souscription pour moins de deux cent cinquante mille francs.

Je m' arrête. Ecrire me fatigue encore par l' obligation de courber la tête.

Tous les affectueux souvenirs de Mme Pasteur et de moi, à Mme Marcou et à Monsieur Philippe, à toi mille bonnes amitiés.

L. PASTEUR."

JULES MARCOU.

CAMBRIDGE, MASS, 14th November, 1895.

HOLBROOK CUSHMAN.

HOLBROOK CUSHMAN was born in New York City, in 1857, and was there prepared for college, entering Columbia in 1874. He was graduated with honors in 1878, receiving the 'Fellowship in Science.' From Columbia he went to the University at Würzburg, Bavaria, studying physics with Kohlrausch, mathematics with Prym and