ganism. To say *ignoramus* does not mean that we must also say *ignorabimus*. I do not believe that a confession of ignorance leaves us with no recourse save vitalism. To maintain that observation and experiment will not bring nearer to a solution of the puzzle would be to lapse into the dark ages. Perhaps Professor Henderson is right when he expresses his belief that organization has finally become a category that stands beside those of matter and of energy. Perhaps there is no problem or none that we can formulate without talking nonsense. Perhaps we should go no further than to record and analyze the existing order of phenomena in living systems without losing sleep over the imaginary problem of a unifying principle. Let us politely salute all these uncomfortable possibilities and go our way. For my part, I find it more amusing to look forward to a day when the great riddle may give up its secret.

EDMUND B. WILSON

DARWIN AND PASTEUR: AN ESSAY IN COMPARATIVE BIOGRAPHY[1]

PLUTARCH'S "Parallel Lives," although read and admired throughout the ages, have found remarkably few imitators. Why this is so would be an interesting question. Perhaps the rise of Christianity, with quintessence of altruism and an instinctive recognition that comparisons, if not necessarily odious, are often unkind, has something to do with it. Perhaps the spirit embodied in that most charitable of pagan maxims—*de mortuis nil nisi bonum*—has also played its part. The modern neglect of Plutarch's method is the more remarkable because it is the basic method of modern science, and the tap root of modern thinking and working. Science owes an immense and growing debt to comparative anatomy, comparative geology, comparative physiology, and comparative pathology. More lately it has produced also the rich fruits of comparative philology, comparative philosophy, comparative politics, comparative psychology, comparative religion and comparative literature. Why not, then, back to Plutarch and the potential field of comparative biography?

Ruminating thus in the blessed quiet hours of a professorial holiday, and braced by the cool airs of an Alpine valley, I could not resist the temptation to revive Plutarch's method by a comparison of the two great master minds of the Victorian era whose labors have thrown upon the mysteries of the living world a clear and penetrating light, a blaze which time may dim but can never extinguish.

Charles Robert Darwin wrought upon the mind of his time a complete change in the point of view concerning the origin, the nature and the relationships of mankind and other living things. Louis Pasteur disclosed to the astonished gaze of the nineteenth century a new world of microscopic life dwelling upon us, within us, and about us, working sometimes for good and sometimes for evil. Darwin was a silent Savonarola, Pasteur a sedentary Columbus of Biology. Such masters invite study and comparison.

To Charles Darwin and Louis Pasteur belongs the rare distinction of having changed completely the point of view of their own and probably later generations.

Nothing had been more interesting or more puzzling throughout the ages than the origin and relationships of the various kinds or species of plants and animals. Dogs, cats and sheep; oaks, elms and willows—how did they come to be so alike, and yet so different? The ancients had their theories, but these were set aside or forgotten in the Christian world when the biblical account of creation came to be literally accepted. That account, like many that had preceded it, affirmed a strictly supernatural origin for plants and animals, and so overcame all difficulties. But by the middle of the nineteenth century the world was growing impatient of supernaturalism, especially in the exaggerated form this had taken on in the Middle Ages, and was ready for a change, so that when Darwin published his great work on the "Origin of Species" in 1859 it was com-

[1] The accompanying essay was left uncompleted by the late William Thompson Sedgwick of the Massachusetts Institute of Technology, when he died, as we all wish to, quickly and before his work was finished. Such an essay may be not only especially timely in this Pasteur anniversary, but may also be useful at a time when men of faith are attacked by men of ignorance and credulity.—G. J. P.

paratively easy for him to convince his contemporaries that the various kinds of plants and animals (including man) have come into existence gradually and naturally, rather than suddenly and supernaturally. This he did by powerful arguments supported by long chains of evidence for the transmutation of species mainly under the influence of a new principle or natural law which he called natural selection, and Herbert Spencer named the survival of the fittest. The simple supernatural theory had long failed to satisfy the minds of many thoughtful men, but, since these could not discover any other or more reasonable explanation of the great mystery, they either adopted the waiting attitude of agnosticism or else acquiesced nominally and perfunctorily in the current hypothesis. Meanwhile, a way had been paved for the easier acceptance of the Darwinian theory of gradual transmutation by the geologists, some of whom were now teaching that the various features of the earth had come into being slowly and naturally rather than suddenly and supernaturally, and by the archeologists who were finding almost daily evidences of the great antiquity of man and of his low condition in antiquity.

Hardly less interesting to mankind than his own origin and the origin of other forms of life have been, throughout the ages, the origins of plague, pestilence and sudden death. Those fearful phenomena, however, seemed to our more thoughtful forefathers hardly more mysterious than did swift decay or riotous putrefaction, while the fermentation of wine and beer and bread had long puzzled the wisest. Here, too, in ancient and medieval times, supernatural explanations were invoked, and here also for those who could not entertain such explanations, and for almost everybody by the middle of the nineteenth century, the waiting attitude of agnosticism had come to be the only rational attitude. Almost at the very moment when Darwin startled the world by the publication of the "Origin of Species," that other seer of the nineteenth century, Louis Pasteur, was solving the problems of fermentation, putrefaction and decay which, as he soon discovered, led him straight into the tangled mysteries of contagious and infectious diseases.

Happily, we possess of these two men full and intimate biographies, Darwin's by a son, and Pasteur's by a son-in-law. For Darwin we have also a brief but precious autobiographic sketch, and it is understood that M. Vallery-Radot must have had Pasteur's assistance in his work. None who wishes to feel for himself the spirit of nineteenth century science should fail to peruse these two great biographies. And if, along with these, or after them, he turns to that of Thomas Huxley by his son Leonard, he will be at once instructed, entertained and amused by the life-history of Darwin's great apostle, one of the bravest, brightest, honestest and wittiest of Victorian Englishmen.

Darwin and Pasteur were for sixty years contemporaries, but Pasteur was the younger by thirteen years. Darwin was born in February, 1809, Pasteur in December, 1822. Born thirteen years apart, they died thirteen years apart, both at the age of seventy-four years. The two youths, as things go to-day, were near neighbors, for Paris and London are not now far apart. But when they were boys or young men this was not the case. Napoleon, whose great deeds formed—so Pasteur's biographer tells us—a kind of historical background of glory for the Pasteur family, was at the same time probably thought of with disgust in the Darwin household. France and England had long been hereditary enemies rather than friendly neighbors, and the two boys, though so near, grew up with very different ideals and under different conditions. Both had good parents and good homes, but Darwin's parents were gentlefolk, while Pasteur's were hardworking tradespeople. Darwin's father was a well-to-do practising physician, Pasteur's an impecunious tanner. Darwin's grandfather, Erasmus Darwin, had a strong taste for science, coupled with an imagination which led him to write verses entitled "The botanic garden." Pasteur's father was a veteran of the Napoleonic wars, proud of his loyal service. His grandfather was an unsuccessful tanner. Darwin's mother was Susannah Wedgwood, daughter of Josiah Wedgwood, the successful and famous manufacturer of pottery. Pasteur's mother was Jeanne Roqui, the daughter of a gardener. Through her mother the Pasteurs later inherited some small sum. Pasteur's mother was "very active,

full of imagination" and enthusiasm. Of Darwin's mother, who died when he was only eight years old, we know but little, but her grandson says "we may hazard the guess that Charles Darwin inherited from the Wedgwood side his sweetness of disposition, while the character of his genius came rather from the Darwin grandfather."

The schooling of the boys was different. For Darwin it was the regular training of well-to-do English boys, *viz.*, a public school; for Pasteur, the corresponding French training for a poorer boy. For the Darwin family it was much a matter of course; for the Pasteur family a hard struggle nobly conceived and bravely executed. The boys themselves seem to have been not unlike other boys; not very studious, not very appreciative of their opportunities. At that time, no one, probably, would have predicted for either any great distinction above his fellows.

As to religious training we are told but little for either, but we get the impression that while Pasteur was surrounded by an atmosphere of strong Roman Catholic piety, Darwin had the ordinary and conventional religious training of a Church of England family.

In his nineteenth year Darwin is uncertain of his career, giving his father anxiety, and shifting from would-be physician to clergyman. He goes to Cambridge and, though to be a clergyman, drifts into a sporting set which sometimes drinks too much. No word is ever said about the want of money. Pasteur in his nineteenth year has just taken his *bachelier ès lettres* and has become a kind of sub-master in the college of Besançon. He was by this time in deadly earnest—too earnest. Unselfishly and bravely he offers to pay for his sister's schooling, though earning only 24 francs a month.

At 22, when American boys leave college, Darwin begins his real life work—engaging to go on the *Beagle* and giving up medicine and divinity. At 22 Pasteur is in training at the Ecole Normale and teaching his old father science.

At 30, Pasteur is three years married and deep in his researches on the tartrates. At 30, Darwin marries and writes up his *Beagle* Journal, a geologist and recognized as a good man of science but hardly as yet for original work.

At 40 (1849) Darwin is engaged in "the slow journey towards the origin of species." At 40 (1862) Pasteur had studied fermentation of beer and vinegar. Was elected to the Academy and advised by Balard and Dumas to give up crystallography and prosecute his studies of ferments.

At 50 (1859) Darwin published his "Origin of Species." At 50 (1872) Pasteur, like Luther, propounded his theses in the fire of controversy.

At 60 (1869) Darwin is now fighting, too. At 60 (1882) Pasteur is triumphant.

At 70 (1879) Darwin is practically triumphant. At 70 (1892) Pastur is completely triumphant.

Pasteur, more intense, impatient, more enthusiastic, more conscientious, became serious earlier, achieved earlier, married earlier, won distinction earlier, aroused controversy earlier, triumphed earlier, but did not die earlier. Pasteur had better health (the first wealth is health) though once almost killed by overwork.

For both the non-effect of environment.

For both industry, concentration, struggle.

For both natural law in place of mystery.

For Pasteur, minutæ, laboratory, precision.

For Darwin, broad principles, masses of evidence, field work, less laboratory.

For Pasteur, "the infinitely little."

For Darwin, the continuing development of mankind.

Both Darwin and Pasteur were fortunate in bringing out their great ideas at the right time. (Agnosticism in medicine, agnosticism in cosmology). The world was tired of supernaturalism and ready for naturalism. It was tired of confusion and ignorance concerning disease, and eagerly embraced the germ theory.

The fame of Darwin has grown greater with the passing years. Darwinism has already become merged and may one day become submerged in the broader doctrine of evolution, of which it was the forerunner. Pasteur's name, curiously enough, is popularly best known in pasteurization, a process of applied science employed long before his day under other names and no name, but first made rational and scientific by him. But Pasteur's original ideas

and discoveries have spread like an infection until to-day they cover the earth.

Darwin, the master of the organic world, sleeps near Newton, the master of the inorganic, in the great Abbey, among the most famous of his race. Pasteur rests alone in the chapel of his laboratory. The world claimed Darwin's body to place among its great ones. Science kept Pasteur's for its own. Both dwell forever among the immortals. The last half of the nineteenth century may well be called their age—the Age of Darwin and Pasteur.

EDWARD EMERSON BARNARD

THE death of E. E. Barnard on February 6, 1923, brought to a close a life and a career which were at once among the most notable and the most inspiring recorded in the annals of American science. The loss will be felt almost as keenly in every country where science is cultivated and loved. Here and there in every generation there breaks through the magma of our common clay a man whose mind is lighted and whose will is energized by a ray of genius. Such a man was he. The manner in which Nature chooses her sparking points and brings together the unusual elements of personality which make a marked man is only beginning to be recognized.

The outward circumstances of Mr. Barnard's life are so well known to most readers of SCIENCE that recitation of them is barely necessary. Even to himself as he struggled and won there must have come often the thrill of romance. To others, unacquainted with the details of his heroic struggle, he personifies in his life the freedom, the opportunity, the vigor and love of action inherent in our great democracy. Sketches and books will be written about him. No better investment in personality could be made than to render the facts and circumstances of his life and work easily accessible to the boys and girls of our country, whom he loved so well and believed in so fervently.

Mr. Barnard was born in Nashville, Tennessee, December 16, 1857, and died in his home near the Yerkes Observatory in the evening of February 6, 1923. His father died before he was born and his mother in 1884. One brother survives him. His early education was given him by his mother. His work as a boy helper in the photographic studio of the brothers Calvert in Nashville and the loan of Dr. Thomas Dick's book, "The Practical Astronomer," combined to stir his imagination and direct his attention toward the subject which was to become his lifelong and sole passion, astronomy. The acquisition of a five-inch telescope in 1877 led him on in his study of the celestial objects, notably Jupiter. In this year the annual meeting of the American Association for the Advancement of Science was held in Nashville and he became a member. On January 27, 1881, he married Miss Rhoda Calvert, the gentle sister of his employers, whose life became devoted most completely to solicitous care for her husband and whose death came less than two years before his own.

On the morning of May 12, 1881, he found a faint comet in the field with Alpha Pegasi and after observing it again the next morning he telegraphed the discovery to Mr. Lewis Swift, of Rochester, N. Y., a veteran comet-seeker. In spite of diligent search by both of these men, and by others, no further trace of it was ever found. Either just before or after this experience Mr. Barnard began his systematic search for comets and on September 17 he was rewarded by finding the comet which is known as Comet VI 1881. Before he left Nashville to join the newly organized staff of the Lick Observatory on Mount Hamilton in California he had discovered nine new comets. He later found seven more, bringing his total up to sixteen. One of these he found by photography on October 12, 1892, the first ever found in this manner.

His early discoveries and his earnestness and zeal attracted the attention of the chancellor and the instructors of the recently established Vanderbilt University at Nashville. In 1883 he was offered a fellowship at Vanderbilt and was given such sympathetic assistance that by tutoring and studying day and night he was able to graduate in 1887. During this time he was in charge of the university's six-inch telescope. In 1889 he received the A.M. degree of the University of the Pacific, in 1893 the degree of Sc.D. from his alma mater and in 1909 the degree of LL.D. from Queen's University, Kingston.

At the Lick Observatory his association with Sherburne Wesley Burnham cemented a friendship which lasted for life. Mr. Burn-