Bernard Jaffe

MEN OF SCIENCE IN AMERICA

OVERSEAS EDITIONS, INC.

MEN OF SCIENCE IN AMERICA

By Bernard Jaffe

OVERSEAS EDITIONS, INC.

FOREWORD

IF HALF of the members of an orchestra were absent at the beginning of a concert and the others persisted in playing alone, the result would be very strange. It might be difficult to recognize the composer's intentions, for one cannot omit some of the parts without spoiling the whole pattern. For similar reasons one might say that it is impossible to tell the history of American science. If one tried to explain the simultaneous development of European science, the account would be enormously lengthened; if one spoke only of American achievements, the story would be like a symphony with the brasses and woods left out.

Science is essentially international or supranational. There are no scientific problems which are exclusively American. There is no American science, but there are American scientists, a good many of them, and some of them as great as may be met anywhere else in the world. The best way to explain American achievements is to focus the reader's attention upon a few of the leading scientists. Bernard Jaffe has done that remarkably well, restricting his account to some twenty leaders, but taking care to introduce into his narrative a host of other men, some of them as distinguished as the leaders themselves. By the way, in spite of the author's skill in selecting chapters which were richer in American deeds, he has been frequently obliged to speak of European ones, otherwise his story would have ceased to be intelligible. This bears out what we said at the beginning: even the most American sections of the history of science are international to a degree.

The first chapter, devoted to Thomas Harriot, who published his description of Virginia as early as 1588, is a sort of colonial introduction. The three following chapters introducing the two Ben-

jamins, Franklin and Thompson, and Thomas Cooper, Jefferson's friend, illustrate the gradual transition to independence. The rest —that is, the bulk of the book—tells the story of the nineteenth and twentieth centuries. Thus many successive chapters deal with contemporaries, we are given many interlocking views of the same periods and the same environments, and the total is a very striking picture of what might be called after all "American science," meaning science in America.

The selection of the twenty leaders is somewhat arbitrary, and no two scholars would agree on it completely; yet it is satisfactory, because its disputable exclusiveness is compensated by an abundance of well-chosen digressions. For the sake of curiosity, rather than criticism, I asked myself how these twenty men were distributed as to their geographical origin. Five were born in Europe, two of them (Harriot and Cooper) in England, one in Germany (Michelson), one in Switzerland (Agassiz), and one in Constantinople (Rafinesque); the two last named might be said to represent French culture. As to the fifteen American-born, almost one third (Franklin, Thompson, Morton, Langley) hailed from Massachusetts; three came from New York State (Henry, Dana, Marsh), and the remaining eight are the sons of eight different states, Connecticut (Gibbs), Pennsylvania (Say), Virginia (Maury), Kentucky (Morgan), Georgia (Long), Missouri (Hubble), South Dakota (Lawrence), and California (Evans). The geographical distribution would not be sufficiently broad, if Jaffe's selection had to be ratified by the United States Senate, but it is pretty good. I imagine that the author did not bother about it. It is accidental, and it is for that reason that it is so interesting.

The scientific progress achieved in the United States in less than two centuries is almost incredible. It is true we began nobly with such men as Franklin and Jefferson, and there never was a time since when Americans could not refer with pardonable vanity to a few contemporary scientists, yet collective triumphs began only in this our century. Consider, e.g., this statement: "The year 1932 was a real *annus mirabilis* in the history of science. Five great discoveries and inventions were made in that single year. The neutron, heavy hydrogen, the positron, and the last of the ninety-two chemical

elements (*alabamine*) were all brought to light for the first time, while the first practical cyclotron was added to the key instruments of physical science. It is interesting to note in this connection that four of these five milestones were first reached by young American scientists, while the fifth, predicted by an American, was discovered by an Englishman. The tempo of first-rate American contributions in science had definitely reached a new high." Jaffe's book is so stimulating, so many of the stories he has to tell are so wonderful, that instead of inviting the reader to appreciate it—as a good prefacer should—I feel it rather my duty to warn him against the danger of being too enthusiastic. Our scientists have done wonders, that is agreed, yet we should not take too optimistic a view of the future.

To begin with, we might remark, in a general way, that complacency is always a symptom of mediocrity and immaturity. It is always better to distrust one's powers and one's wisdom. Boasting cannot be forgiven except to the very young or the very old. American science is in the full bloom of its maturity. The time of boasting is definitely past. If some of our scientists are still tactless enough to indulge in it they should be sent to Coventry.

Even in California, which, if we may judge from the author's selection of living heroes, is the most promising state for the future of science, even in California, the number of scientists per thousand people or per square mile (count it as you please) is still pitifully small. Our scientific potential is very high in a few places, but very low all around. The scientific education (as distinguished from the purely technical training) of our people has been neglected, and the result for all to see is the almost unbelievable success obtained by quacks, faddists, and cultists of every kind. That success is possible only because of the poverty of the scientific spirit, the lack of resistance to irrationality. It is urgent to build up that resistance. The danger is great and the more so, because it is not generally suspected. In fact, there are a good many people who believe themselves to be scientifically minded, because they can make a show of scientific knowledge (often the latest and most controversial), yet have no definite idea of scientific method; their science is pseudo-science, which is worse than ignorance. It is not at all necessary that the average man should be acquainted with the latest theory of the universe

or the newest hormone, but it is very necessary that he should understand as clearly as possible the purpose and methods of science. This is the business of our schools, not simply of the colleges but of all the schools from the kindergarten up.

To nourish superstitions is somewhat comparable to harboring lice and equally disgusting, and if I may push this comparison to its bitter end, I would say that too many of our people—not only of the poor and uneducated, but of the rich, prominent, and fashionable—are lousy. There is nothing in that to brag about. The shops of astrologers, chiromancers, and clairvoyants are as discreditable to a community, and as dangerous to its members, as opium dens. Yet how many people, albeit good, realize that? How many realize that public sanity is as important a matter as public health?

Finally, one should bear in mind that even if science and the scientific spirit were better understood and more widely spread, still we should not be too pleased with ourselves. Science, however necessary it may be, is not sufficient, and it will become more and more insufficient as it increases. There was a time when science sprang up as it were in the shadow of wisdom, but it has grown so exuberantly that wisdom is choked—and that is really frightening. If the same development continued much longer without compensation, science would end in turning itself against humanity. The political events of the last thirty years have made this clear to all but the blind.

Half a millennium ago the Dutch author of the *Imitation of Christ* wrote, "What availeth it to cavil and dispute much about dark and hidden things. . . ." Modernizing the expression of that sentiment one might say, "What is the good of counting galaxies, analyzing stars, and splitting atoms if we have so little wisdom that we make a hell of life?"

The more science there is, the greater the need of toleration and kindliness, not to speak of justice, the greater the need of humanities without which science is not worth knowing and life is not worth living.

To return to Jaffe, the book he has written is the very kind to awaken scientific vocations and to give intelligent and ambitious young men—the potential leaders of tomorrow—the enthusiasm and tenacity which are the conditions of victory. I hope it will strengthen

in every reader the love of science, that is, the love of controllable truth and the dislike of error and superstition, without weakening his feelings of reverence, of humility and charity, without which all the rest is as nothing.

GEORGE SARTON

Harvard Library,
Cambridge, Massachusetts.

INTRODUCTION

THE INCENTIVE which led to this project was twofold. First, there is the general lack of knowledge of the American public about the lives and achievements of our own men of science. This ignorance pervades even the ranks of professional scientists, teachers of science, and students of American history. Historians of the United States have, with glaring uniformity, underestimated the importance of these men to the development of our country. The teaching of key events in the political and economic history of America has been the standard mental diet in our schools for generations. Crucial events in the history of our scientific progress have been almost completely ignored. Little has been taught of the stirring revolutions in human thought which have resulted from scientific advance.

Secondly, no full-bodied attempt has been made by historians of science or biographers of American scientists to paint a complete picture of the growth of science in the United States, especially as it modified the development of our social structure or as the rise of America influenced the kind of science which flourished here. This, too, is a serious omission, for science is an activity and not simply a body of facts. Just as the literature and art of a country are an inseparable part of its history, so a scientific advance may change the course of its destiny. A nation faces a problem which science attacks and solves, and the way of life of millions of people is thereby significantly altered.

Several reasons present themselves for this neglect of so important a phase of the American story. Most writers of the history of the United States have had little training in the sciences and have not, therefore, been equipped for such a task. Other historians have dismissed the problem as one of no great consequence and hence not worth the research which such a treatment would require. Finally,

there were others who feared to explore a field so burdened with pitfalls and obstacles. They were repelled by the obvious difficulties to be encountered in attempting to trace relationships between the march of science and our changing social structure. It is easy enough, of course, to see the cause-and-effect relationships between the invention of the cotton gin and the growth of slavocracy, or between the invention of the telegraph and the development of our railroads and the problems which arose from the peopling of the West. On the other hand, it is not so simple a matter to find interconnections between, let us say, the first synthesis of an organic compound, in 1828, and the intellectual and physical revolutions which this unheralded beginning of synthetic chemistry brought in its train. Similarly, it is not so easy to show the impact of the theory of evolution, which reached our shores in 1859, on the thinking of our people regarding such social questions as the rights of the Negro or the principle that all men are created equal.

Professor Charles Beard expressed the challenge of such an undertaking in his introduction to *The Rise of American Civilization*: "The risks of error are staggering; the danger of folly is greater. But what is the alternative for those who are not content to treat life as an inorganic one-thing-after-another, and history as a string of anecdotes? Perhaps those who try to find paths, even where there are none, stimulate path-finding if only by their mistakes."

It was in this spirit, and with the encouragement of Professor George Sarton of Harvard University, editor of *Isis*, organ of the History of Science Society, that I approached this project. Sarton believes that "the history of science should be the leading thread in the history of civilization," and few today will disagree with him. I set up as my goal the examination of the record, with a view to finding possible relationships between the kind of science which developed in America and the type of civilization which has flourished here. I did not plan to prove any thesis as sweeping as that which insists that "the history of the United States is fundamentally a history of invention and science."

As my jumping-off time and place, I took the visit in 1585 of Thomas Harriot to the New World, which resulted in the publication of his *A Briefe and True Report of the New Found land of Virginia*, the first book in English devoted to the flora and fauna of

what is now the United States. Surveying in this flight a time period of three and a half centuries, I was confronted with the task of gleaning from a host of workers in science just a handful of outstanding men around whom the story could be most accurately and fully told.

The problem of choosing a score of men among several hundred was not a simple one. I therefore set up a basis of selection. The first and most important criterion was the significance of the man's scientific contributions when judged as *pioneer* research. These pioneers were given first placement regardless of all other considerations because first steps in a new field are usually the most difficult. On this basis, for example, the researches of Benjamin Thompson on the nature of heat, which ultimately destroyed the mischievous theory of caloric, could not be omitted.

Other less important considerations were: (1) The awareness of the scientist of the social scene in which he worked, at least insofar as he participated in the political, economic, or social movements of his day. By this standard Thomas Cooper, friend of Jefferson, Priestley, and Paine, an active participant in the political and educational turmoil of the early years of the struggling republic, was chosen over Robert Hare, inventor of the oxyhydrogen blowpipe used in chemical analysis. (2) The field in which the scientist labored, so that as many different segments of scientific exploration as possible could be included in the final picture. On this basis, Thomas Say, pioneer entomologist, was chosen rather than William Beaumont, whose researches in physiological chemistry could nevertheless be mentioned in the chapter dealing with medical advance. (3) Emphasis on pure science rather than on invention and applied science. Hence Samuel Langley's work in aerodynamics was given preference over the pioneer experiments of the Wright brothers with heavier-than-air flying machines. The four final chapters were reserved for the researches of contemporary scientists in those fields where American men of science have pioneered with outstanding success.

For a consensus on whom to include in this select galaxy of about twenty men, I consulted several published lists of eminent American scientists, such as Dr. Jordan's *Leading American Men of Science* and Dr. Youmans' *Pioneers of Science in America*. I also examined the list of ten men selected by the American Museum of Natural

History in 1906 as those who had done most to advance science in America. (This list consisted of Agassiz, Audubon, Baird, Cope, Dana, Franklin, Henry, Humboldt, Leidy, and Torrey.) New York University's Hall of Fame was also helpful. Out of a total of seventy-three distinguished Americans so far elected to the Hall of Fame, thirteen are scientists. These thirteen names are:

John James Audubon	(1785-1851)	elected 1900 by	67 votes
Benjamin Franklin	(1706-1790)	1900	94
Robert Fulton	(1765-1815)	1900	86
Samuel F. B. Morse	(1791-1872)	1900	82
Eli Whitney	(1765-1825)	1900	69
Asa Gray	(1810-1888)	1900	51
Miria Mitchell	(1818-1889)	1905	48
Louis Agassiz	(1807-1873)	1915	65
Joseph Henry	(1799-1878)	1915	56
Elias Howe	(1819-1867)	1915	61
William T. G. Morton	(1819-1868)	1920	72
Matthew F. Maury	(1806-1873)	1930	66
Simon Newcomb	(1835-1909)	1935*	78

In this preliminary search I even included the scientists honored on United States postage stamps; namely:

John J. Audubon
Alexander G. Bell
Luther Burbank
John Ericsson
Benjamin Franklin
Robert Fulton
William C. Gorgas
Elias Howe
Crawford W. Long
Cyrus H. McCormick
Samuel F. B. Morse
Walter Reed
Eli Whitney
Wilbur Wright
Orville Wright

With the above sources serving as leads, I read widely in the fields of the history and biography of science, turning especially to a large number of original papers. Out of this reading grew another list which I discussed, either in person or through correspondence, with several eminent scientists. The discussions were illuminating, and

* Gibbs, Reed, McCormick, Westinghouse, and Cyrus Field lost by a few votes in the 1940 election to Stephen Foster, composer of American folk songs.

often led to further investigations and new revampings of the list. Even at the very close of this exploratory period, wide differences of opinion remained in some cases. The inclusion of Franklin, Gibbs, and Henry found general acceptance. Sectionalism entered into the question of whether to select Dr. Morton of Massachusetts or Dr. Long of Georgia. Here the difficulty was easily resolved because the story of anesthesia is the story of both of these pioneers.

Rather strong personal views punctuated the discussions over the inclusion of Agassiz as against Asa Gray. One eminent zoologist so completely debunked the importance of the Swiss-American as a creative scientist that he was willing to preserve him in the final list only because of his importance as a popularizer of scientific education. Agassiz, incidentally, was the only American scientist besides Franklin to appear in a list of thirty-five American Immortals which Dumas Malone, editor of the *American Dictionary of Biography*, "speaking as a biographer and not as a scientist," prepared about twenty years ago. In explaining his selection, Malone remarked, "Little can be written about the lives of most scientists because there is nothing much to say. On quantitative grounds, therefore (that is, the number of lines of biographical material which followed their names), they were eliminated from this list as were Fulton, Morse, Whitney, and Ericsson, the inventors." This is an interesting reflection of what America knew about her men of science.

The inclusion of Thompson, Dana, and that triumvirate of paleontologists of the 1870's—Marsh, Cope, and Leidy—was also generally agreed upon. Say and Cooper were practically unknown names to most of the scientists I consulted, and for the most part still remain neglected and overshadowed. There was some difference of opinion over the choice of Rafinesque instead of Audubon. Rafinesque remained in the list because he was an unusual collector, systematizer, and polyhistor—a real titan among our early naturalists.

In the selection of contemporary scientists I hardly hoped to obtain universal agreement; first, because I was limited to just a few names, and secondly, because we are still too close to these men and their achievements to be able to evaluate their work with complete objectivity. The final list which appears in the Table of Contents is, of course, not an exhaustive one. The work of dozens of other men is mentioned in the story.

Before the first draft of the book had been completed, a number of interesting ideas began to emerge. Until recently, for example, the scientific contributions of America were largely in applied science and invention rather than in pure or theoretical science. American men of science had shown extraordinary ingenuity in building new tools of science and in applying pure science to material progress. The U. S. Patent System had been created on April 10, 1790, by George Washington in the first year of the republic under the Constitution. Between the time of the establishment of our Patent Office in 1836 and the year 1860 some 36,000 patents were granted to Americans. It is no wonder that Abraham Lincoln remarked that the Patent System "had added the fuel of interest to the fire of genius."

During the next thirty years another 650,000 patents were issued, and between 1890 and 1935 an additional million and a quarter American patents were taken out. The United States has actually led the world in the number of patents registered—twice as many as Great Britain or France and four times as many as Germany. At the hundredth-anniversary celebration of the establishment of the U. S. Patent Office, which was held in Washington, D. C., in 1936, a research parade was presented. The twelve greatest inventions of the country were selected by a committee and listed as follows (the order is purely chronological):

Cotton Gin	1793	Eli Whitney of Massachusetts
Steamboat	1809	Robert Fulton of Pennsylvania
	and 1786	John Fitch of Connecticut
Reaper	1834	Cyrus McCormick of Virginia
Telegraph	1837	Samuel F. B. Morse of Massachusetts
Rubber Vulcanization	1839	Charles Goodyear of Connecticut
Sewing Machine	1846	Elias Howe of Massachusetts
Airbrake	1872	George Westinghouse of New York
Telephone	1876	Alexander G. Bell (born in Scotland)
Incandescent Lamp	1880	Thomas A. Edison of Ohio
Linotype Machine	1884	Ottmar Mergenthaler (born in Germany)
Commercial Aluminum	1886	Charles M. Hall of Ohio
Airplane	1903	Wilbur Wright of Indiana and Orville Wright of Ohio

To this list might be added at least four more:

Typewriter (first practical)	1868	Christopher L. Sholes of Pennsylvania
Phonograph	1877	Thomas A. Edison
Radio Tube (3-electrode)	1906	Lee de Forest of Iowa
Bakelite	1909	Leo H. Baekeland (born in Belgium)

Some of these inventions were improvements, developments, or applications of scientific principles discovered outside our own borders. The first practical steamboat, for example, was made possible by the adoption of the steam engine to water transportation. Other inventions such as the telegraph, telephone, incandescent lamp, and airplane were the results of the application of principles discovered in the realm of pure science either wholly or in great measure by our own scientists. Still others, such as the cotton gin, reaper, and sewing machine, were the products of sheer mechanical ingenuity. The harnessing of the internal-combustion engine in automobiles, the development of the modern radio and of the moving-picture machine, the huge increase in our varieties of steel and other alloys, the opening up of a whole new field of plastics by the inventions of celluloid and bakelite; our advances in the refining and cracking of petroleum and our first-rate contributions to the new chemical world of synthetic fibers, dyes, drugs, vitamins, and hormones—all are but a few examples of our leadership in the practical utilization of scientific principles. Eli Whitney's introduction of the use of interchangeable parts in the manufacture of machines and tools was another revolution which may well be credited to America. The assembly line, as well as our huge, intricate, uncannily efficient continuous-process machines such as those used in the manufacture of glass and steel, is a further example of America's superior role in applied science.

The reasons for this tremendous output of practical applications of science lie in the nature of the social forces which have been at work in the building of the United States. From the beginning, our people were engaged in subduing a land of great area, a land rich in natural resources and, in the early years, low in man power. We were a new country. Immense forests waited to be stripped. Mountains of iron, copper, silver, gold, and other metals had only to be mined. Enormous deposits of coal and bursting reservoirs of petroleum

needed but to be tapped to yield a steady flow of power. Fertile fields, vast prairies, rich forests smiled graciously on the pioneers, waiting to be peopled and exploited. But mountain barriers, rushing rivers, arid plains, and burning deserts had to be crossed. The mind, the labor, and the energies of our forebears were occupied for two hundred years with the immediate problem of conquering a country and holding dominion over it. The inventive genius of our people was challenged to produce new and swifter means of transportation and communication as well as labor-saving devices to accomplish this prodigious task. The inventive capacities and the technological skills of America were stimulated to a fever heat.

A powerful native royalty emerged from this restless people dazzled by the possibilities of new conquests and new acquisitions. Railroad magnates, oil kings, coal barons, steel manipulators, and other monarchs of industry fought one another in applying the fruits of science to the piling up of huge fortunes and the building of a new country. There was little time and less thought for abstract science when every one of its values was approached in terms of exploitation, service, and function. Alexis de Tocqueville, a distinguished European who visited the United States during the Jacksonian era, wrote, "The spirit of the Americans is averse to general ideas and does not seek theoretical discoveries." Theoretical speculation and contemplative philosophy in science were engulfed in the mad rush to exploit a land bursting with colossal physical resources. In such an atmosphere the pragmatic philosophy of William James was born, and the guiding star of "learning by doing" rose under the leadership of John Dewey.

The point has frequently been made that while in applied science the United States has kept pace with and even forged ahead of our European contemporaries, we have lagged behind in the realm of pure science—the search for truth with no thought of practical application or pecuniary reward. We have been reminded that in our annals of science there is no Darwin, whose scientific genius shaped the cumbersome mass of data in the world of biology into a theory which revolutionized man's idea about his place in the scheme of living things. Biographers have fruitlessly searched, we are told, in our magnificent universities for an American-born peer of Einstein, who introduced into modern science as sweeping a synthesis of

physical phenomena as did Newton before him in England. They cannot find, they insist, an American counterpart of James Clerk Maxwell, who with rare insight enunciated the electromagnetic theory of light and successfully predicted the discovery of wireless waves. We have given the world, they claim, no equal of Pasteur, who proved the germ theory of disease which forever destroyed the demoniacal conception of illness and launched a momentous new era in medicine.

Does the record of scientific achievement in the United States bear out this generally accepted point of view? Let us examine the ledger. American science had its birth in the electrical researches of Benjamin Franklin. Less than two hundred years have gone by since those immortal experiments were performed in Philadelphia. What was happening in the scientific laboratories of the rest of the world during this same period? Said Millikan, "If I were asked to list the most influential scientists who have lived during the eighteenth and nineteenth centuries, I should bring forward the following eleven names:

Benjamin Franklin	1706-1790	American
Pierre Laplace	1749-1837	Frenchman
Michael Faraday	1791-1867	Englishman
James Clerk Maxwell	1831-1879	Englishman
Charles Darwin	1809-1882	Englishman
Auguste Fresnel	1788-1827	Frenchman
Louis Pasteur	1822-1895	Frenchman
Karl F. Gauss	1777-1855	German
Hermann Helmholtz	1821-1894	German
Alexander Volta	1748-1827	Italian
J. Willard Gibbs	1839-1903	American."

In this top-ranking group are three English men of science, three French scientists, two Germans, one Italian, and two native Americans. This list would seem to indicate that among the most eminent scientists who worked during the less than two centuries which followed the birth of theoretical science in America, we produced at least a small number who were the equal of some of those in Europe.

Another list could be presented which would give a less favorable, yet equally interesting picture. Of the eighteen scientists of this same

period who were chosen by our National Academy of Sciences for bas-relief bronze portraits to decorate their Washington building, we find the following distribution:

2 Americans	Franklin and Gibbs
2 Germans	Helmholtz and Gauss
6 Englishmen	Darwin, Faraday, Galton, Joule, Lyell, Maxwell
6 Frenchmen	Bernard, Carnot, Cuvier, Laplace, Lavoisier, Pasteur
1 Austrian	Mendel
1 Swede	Linnaeus

America did make at least a modest contribution to pure science in spite of the many forces which were working against the development of acute scientific thinkers during the years of the building of our republic. Is this because master theoreticians need no particular humus in which to blossom; because among large literate populations great minds are inevitably born and make their influences felt? We must not forget that famous men of science have sprung up in the most unexpected places, without cultural forebears, special training, or exceptional encouragement. Witness the lives and achievements of Benjamin Franklin, who started as a printer's devil; Benjamin Thompson, as a poor schoolteacher; Joseph Henry, son of a day laborer; Matthew Maury, child of a struggling frontier farmer; James Dana, clerk in his father's store; and Michelson, whose German immigrant father operated a drygoods store in California.

Since men of science, like the rest of us, are citizens of their communities, some laymen believe that the complete aloofness of scientists from the varied activities of the social atmosphere in which they work is an unhealthy state of affairs. They would have the men of the test tube, the telescope, the microscope, the balance, and the scalpel descend from their intellectual towers and join their fellow citizens in the solution of social, political, and economic problems. Others maintain that the scientist best serves the interests of mankind by unselfish and single-minded devotion to the laboratory problems for the solution of which he has been specially trained.

It is a fairly general opinion that American men of science have almost completely ignored the social scene and have been content to