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AND "LOW MECHANICKS"

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Dedicated to the memory of Paul Siegel
(1916–2004)

In the beginning was the word.

—*The Gospel according to St. John*

In the beginning was the word? . . .

No, in the beginning was the *deed*.

—GOETHE, *Faust*



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ACKNOWLEDGMENTS

THE ADJECTIVE “PEOPLE’S” in the title of this book may prompt the suspicion that I am one of those authors who “wave some dimension of history in front of their readers, claiming that it is the forgotten grand arcanum, the key to Clio’s mysteries.”¹ To the contrary, the elements of a people’s history of science have already been created by a great number of historians whose research broke the ground and planted the seeds that were essential to the making of this book. My task, as I saw it, was to synthesize their findings and present them as a coherent narrative suitable for consumption by an audience of nonspecialists.

Among those authors to whom I am most indebted are the originators of people’s history of science, Boris Hessen and Edgar Zilsel; some key continuators, including J. D. Bernal and Joseph Needham; and some present-day practitioners, including William Eamon, Steven Shapin, Pamela H. Smith, Deborah Harkness, Adrian Desmond, and Stephen Pumphrey. Others whose work I have found very helpful are Eva Germaine Rimington Taylor, Silvio Bedini, Derek J. de Solla Price, Roger Hahn, and Roy Porter. I am especially fortunate to be able to count among my graduate school mentors two pioneers of the social history of science, James Jacob and Margaret Jacob. The Jacobs introduced me to the ideas that led me to write this book but should not be held responsible for what I have made of them.²

Science for the People, a periodical that appeared throughout the 1970s and ’80s, helped shape my understanding of the relation between science

and society. This book also owes an obvious debt to previous people's histories, most notably A. L. Morton's *A People's History of England* and Howard Zinn's *A People's History of the United States*. Peter Linebaugh is another people's historian whose work has served to inspire me. As for Howard Zinn, I am grateful not only for the example provided by his writings but for the warmth of the encouragement he has given me from the time I first submitted the proposal for this book to him.

My deepest thanks are due to a number of scholars (who also happen to be good personal friends) for reading all or parts of draft versions of this book and providing suggestions that enriched the final product. In addition to the aforementioned James Jacob, they include anthropologist Kim Sonderegger, art historian Greta Berman, and my dear, departed friend, the literary scholar Paul Siegel.

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Without the special talents and efforts of literary agents Sam Stoloff and Frances Goldin, this book would probably still be in manuscript form, languishing in the piles of unread drafts in publishers' offices. I owe my introduction to them and to Howard Zinn to another close friend, Jeff Mackler, whom I met more than three decades ago when we were both active in the trade union and antiwar movements. Jeff is, among other things, currently a national leader of the efforts to win justice for Mumia Abu-Jamal. In that capacity, he works closely with Frances Goldin, Mumia's literary agent, and was kind enough to recommend me to her as a client. I thank Sam Stoloff not only for representing me to publishers but also for a number of valuable suggestions that have improved the text. Warmest thanks also to Carl Bromley and Ruth Baldwin, my editors at Nation Books, for doing what editors do, and doing it so well.

My greatest appreciation is for my spouse, Marush Conner. The Cajuns have a term of endearment that perfectly expresses what she is to me—she is

ma toute-toute: research collaborator, ballerina, travel coordinator, French-language resource, life companion, confidante, best friend, sublime playmate, and everything else that makes life worth while.

- ^{1.} Roy Porter and Mikulás Teich, eds., *The Scientific Revolution in National Context*, p. 6.
- ^{2.} The works I have drawn on by the authors mentioned in this paragraph and the next are listed in the bibliography.

WHAT SCIENCE? WHAT HISTORY? WHAT PEOPLE?

WE ALL KNOW the history of science that we learned from grade-school textbooks: how Galileo used his telescope to show that the earth was not the center of the universe; how Newton divined gravity from the falling apple; how Einstein unlocked the mysteries of time and space with a simple equation. This history is made up of long periods of ignorance and confusion, punctuated once an age by the “Eureka!” of a brilliant thinker who puts it all together. In this traditional heroic account, a few Great Men with Great Ideas tower over the rest of humanity, and it is to them that we owe science in its entirety.

The legend of Pythagoras exemplifies the seemingly timeless tendency to attribute all scientific creation to individual hero-savants. With regard to ancient Greek and Roman commentaries on their semimythical predecessor, Walter Burkert observed that “to a later age it seemed natural to retroject their own notion of ‘wisdom’ upon the great figures of the past and to impute to them that which from a modern point of view is ‘science.’”¹ Unfortunately, that practice is still all too much in evidence today.

What I am presenting here, by contrast, is a *people’s* history of science that aims to show how ordinary humans participated in creating science in profound ways. It is a history not only *of the people* but *for the people* as well; its intended audience is not confined to professional scientists or

historians of science but includes anyone with an interest in the origins of scientific knowledge. And because I have drawn on the collective efforts of many predecessors, it might not be far-fetched to say that in a sense it is also *by the people*.

My central aim is to demonstrate a much, much greater contribution to the production and propagation of scientific knowledge on the part of anonymous masses of humble people—the common people—than is generally recognized or acknowledged. Isaac Newton’s ability to “see further” should not be attributed, as he claimed, to his sitting “on the shoulders of giants,” but rather to his standing on the backs of untold thousands of illiterate artisans (among others).²

It would be absurd, of course, to claim that the formulation of quantum theory or the structure of DNA can be credited directly to artisans or peasants, but if modern science is likened to a skyscraper, then those twentieth-century triumphs are the sophisticated filigrees at its pinnacle that are supported by—and could not exist apart from—the massive foundation created by humble laborers. If science is understood in the fundamental sense of *knowledge of nature*, it should not be surprising to find that it originated with the people closest to nature: hunter-gatherers, peasant farmers, sailors, miners, blacksmiths, folk healers, and others forced by the conditions of their lives to wrest the means of their survival from an encounter with nature on a daily basis.

A few brief examples—all of which will be explained in detail in the chapters below—can illustrate this contention. Virtually every plant and animal species we eat today was domesticated by experimentation and de facto genetic engineering practiced by preliterate ancient peoples. We are infinitely more in debt to pre-Columbian Amerindians than to modern plant geneticists for the scientific knowledge underlying food production. Even in relatively recent times, when American plantation owners wanted to grow rice, they found themselves compelled to buy African slaves with knowledge of the ecology of rice plants.

Likewise, the science of medicine began with and continues to draw on knowledge of plants' therapeutic properties discovered by prehistoric peoples. Amerindians demonstrated to Europeans the efficacy of the bark of the cinchona tree in treating malaria, and an African slave named Onesimus introduced the practice of inoculation against smallpox to North America. Credit for the discovery of vaccination that usually goes to Dr. Edward Jenner belongs instead to a farmer named Benjamin Jesty. Furthermore, until the nineteenth century the advance of medical science owed more to semiliterate barber-surgeons, apothecaries, and "irregular" healers than to university-trained medical scholars, whose influence tended to retard the acquisition of new medical knowledge. It was a Swiss pig-gelder named Jakob Nufer who in the 1580s performed the first recorded cesarean section.

The geography and cartography of the Americas and the Pacific Ocean are founded on the knowledge of the native peoples. Captain John Smith acknowledged that his celebrated map of the Chesapeake Bay area "was had by information of the Savages," and Captain Cook's maps of the Pacific Islands were derived from information given to him by an indigenous navigator named Tupaia. Anonymous sailors and fishermen were the original source of scientific data regarding tides, ocean currents, and prevailing winds; when Benjamin Franklin produced the first chart of the Gulf Stream, he acknowledged that it was entirely based on what he had learned from "simple" whalers.

Chemistry, metallurgy, and the materials sciences in general originated in knowledge produced by ancient miners, smiths, and potters. Mathematics owes its existence and a great deal of its development to surveyors, merchants, clerk-accountants, and mechanics of many millennia. And finally, the empirical method that characterized the Scientific Revolution of the sixteenth and seventeenth centuries, as well as the mass of scientific data on which it built, emerged from the workshops of European artisans.

The "folk" wisdom and lore of early societies was not an inferior kind of knowledge about nature that later was simply canceled out and replaced by more accurate scientific knowledge. Science as it exists today was *created*

out of folk and artisanal sources; it became what it is by drawing heavily on those sources. Knowledge, philosopher of science Karl Popper maintained, has for the most part advanced through the modification of earlier knowledge.

It might be argued that the approach I have outlined here cannot produce a balanced account of the origins of modern science. But the historical record has long been severely unbalanced by the gentlemen's historians and by the nature of history's dependence on written documentation, with power relationships determining who did the writing. No history of science could be less balanced than the traditional romantic narratives of Newtons, Darwins, and Einsteins transforming the world by the force of their unique brainpower. I am deliberately "bending the stick in the other direction," searching for the voices of the voiceless and sifting the record for very scarce evidence. The purpose of the sifting, however, is not to salvage some peripheral aspects of the development of science, but to demonstrate how the scarce evidence illuminates the hidden core of that development.

A selective approach does not necessarily lead to an unbalanced conclusion. Although my focus is on the activities of anonymous, ordinary people, I do not believe I have overvalued their importance in the process of generating scientific knowledge. It is not my contention that the familiar Great Men of Science played no role or were unimportant, but that their achievements were predicated on prior contributions of artisans, merchants, midwives, and tillers of the soil—most of whom have never been thought of as great and many of whom were not men.

Attempts to integrate women fully into the traditional heroic narrative are ultimately unlikely to be satisfying, not because women have ever been genetically inferior to men in intellect but because of the social barriers that historically have denied women education and entrée into scientific professions.³ The contributions of women receive considerably more recognition in a people's history of science because women constitute half of the people, but even here parity is elusive due to the traditional exclusion of women from many craft occupations. But if women did not have much input

in the development of oceanography because few were seafarers, they made up for it in the medical sciences in their roles as local healers and midwives.

The contributions to the history of science made by socially subordinate and illiterate people have not left the paper trail that historians customarily depend on for evidence. Lynn White, for example, blames “the neglect which historians have lavished upon the rustic and his works and days” on the fact that the peasant “has seldom been literate”:

Not only histories but documents in general were produced by social groups which took the peasant and his labours largely for granted. Therefore while our libraries groan with data on the ownership of land, there is an astonishing dearth of information about the various, and often changing, methods of cultivation which made the land worth owning.⁴

The heroes of the traditional story of eighteenth-century scientific agriculture are “improving landlords” such as Jethro Tull and Thomas “Turnip” Townshend, whose spirit of experimentation was allegedly the driving force behind the great leap forward. But as T. S. Ashton explained in his classic study of the Industrial Revolution, “Tull was a crank, and his importance in the history of agriculture has been vastly exaggerated.” As for Viscount Townshend’s role in the introduction of the turnip as a field crop, “recent research has shown that he was the popularizer, rather than the originator, of this.” There was no single originator; it was a collective accomplishment. Agricultural experiments “were being made by obscure farmers in many parts of the country”; then, “knowledge of the new methods was spread at tenants’ dinners, shearing feasts, and the more frequent meetings of many local farmers’ clubs.” On the larger manors it was not the wealthy landlords but their humble tenants whose hands were actually in the soil and the manure, experimenting with new crops and procedures. The new agronomic knowledge, “like every major innovation, was the work of many hands and brains.”⁵

The development of the peasants’ knowledge that “made the land worth owning” is impossible to trace by archival research, and the same is true of

much of the scientific knowledge produced by artisans who were unable to read and write. In recent decades, however, historians have begun to tap the methodology of anthropology and other disciplines to show that a great deal can be learned about the past—and not only the “prehistoric” past—without recourse to written sources. Furthermore, some assertions not supportable by documentation may be deemed valid due to the lack of any viable alternative explanation—for example, the proposition that anonymous sailors and fishermen were the original source of scientific data regarding ocean currents and prevailing winds.⁶

The chronological scope of this survey of scientific history is as vast as it could possibly be—from the Paleolithic to the postmodern—but it is markedly weighted toward a particular period: the fourteenth through seventeenth centuries of the Common Era, which encompass the origins of what has come to be known as *modern* science.⁷ The geographical scope is likewise unlimited but somewhat skewed toward the western end of the Eurasian landmass. My view of history is not Eurocentric, but because this subject is inextricably entangled with the European imperial conquest of the rest of the globe, it therefore demands a disproportionate amount of attention to activities that occurred in Europe.

WHAT PEOPLE?

WHO ARE *THE people* who are both subject and object of this people’s history? Occupational categories—such as artisans, merchants, and so on—give a good first approximation, but how shall they be collectively identified? I prefer to avoid denominating them as *the lower classes* or *the inferior orders*, except in quotation marks indicating irony, because those designations reflect the point of view of the privileged few who have always defined themselves as superior to everyone else. *Common people* and *ordinary people* are slightly pejorative but perhaps not too objectionable; *the masses*, *the working class*, and *the proletariat* are not intrinsically