INTRODUCTION

Eurocentric Scientific Illiteracy—A Challenge for the World Community

Sandra Harding

Scientific Illiteracy: Familiar and Unexpected

An unexpected form of scientific illiteracy has become more and more visible over the last few decades. Earlier criticisms focused on the scientific illiteracy of humanists or of the working classes; recent ones challenge the Eurocentrism or androcentrism of many scientists, policymakers, and other highly educated citizens that severely limits public understanding of science as a fully social process and thus, also, of the nature it studies. According to these latter-day criticisms, scientists and other members of dominant groups in the West also suffer from a kind of scientific illiteracy; they need a kind of scientific education that has not been available to them.

In particular, there are few aspects of the "best" science educations that enable anyone to grasp how nature-as-an-object-of-knowledge is always cultural: "In science, just as in art and in life, only that which is true to culture is true to nature."[1] These elite science educations rarely expose students to systematic analyses of the social origins, traditions, meanings, practices, institutions, technologies, uses, and consequences of the natural sciences that ensure the fully historical character of the results of scientific research. Consequently, most scientists are not in a position to evaluate in a maximally objective way important parts of the evidence that they use in arriving at their results of research; nor is the educated public provided with the information and skills it needs to detect such a problem. Thus public understanding is impoverished by the prevalence of partial and distorted pictures of nature and of the place of Western sciences in maximally objective accounts of world history.[2] For example, the failure of Westerners to link scientific thought about the green revolution, rain forest conservation, or toxic waste disposal to issues of social justice has generated only partial and distorted scientific accounts and policies that increase yet further the gap between the haves and the have-nots. We need "strong objectivity" instead of the only weak standards that have prevailed in the sciences—a topic to which I shall return.

One group that has particularly suffered from this second kind of scientific illiteracy is people constructed as racially or ethnically different or "other" from the dominant groups in the West. What we could refer to as overdeveloped elites in the West have underdeveloped the Third World and the people of Third World descent within the West, as a number of critics have put the point, and Western sciences appear to be deeply implicated in these processes.[3] My focus here will be on this "racial" economy of Western sciences and its accompanying Eurocentrism. By " 'racial' economy" I mean those institutions, assumptions, and practices that are responsible for disproportionately distributing along "racial" lines the benefits of Western sciences to the haves and the bad consequences to the have-nots, thereby enlarging the gap between them.[4] By "Eurocentrism" I mean the assumption that Europe functions autonomously from other parts of the world; that Europe is its own origin, final end, and agent; and that Europe and people of European descent in the Americas and elsewhere owe nothing to the rest of the world.[5]

These are strong charges—but they are the ones that emerge from a broad array of scientific, historical, and philosophic studies such as the ones included in this collection. To repeat a point made in the preface, these are not charges made by critics hostile to science; many of the critics are scientists who are calling for better science. After all, the sciences build in modes of self-correction; making such criticisms and thoughtfully responding to them is exactly how the growth of knowledge is supposed to occur and how it has often advanced in the past. Nor are these critics engaged in bashing specifically Western sciences. The problem is not Western sciences per se but certain configurations within them, such as Eurocentrism, that need to be cut out of our institutions, assumptions, and practices. The solution to these problems for people living in the West is not to end or devalue Western traditions wholesale or to seek escape from them in mythologized sciences of the past or of non-Western societies. Our solution cannot be escape to "elsewhere." Instead, we must learn to take responsibility for the sciences we have now and have had in the past, to acknowledge their limitations and flaws as we also value their indubitable strengths and achievements. But to do so requires a more realistic and objective grasp of their origins and effects "elsewhere" as well as in the West.

Of course, the earlier problems of scientific illiteracy have not disappeared. The earlier concern was that far too many people were ignorant of or indifferent to scientific learning. Some critics, such as C. P. Snow, focused on the "two cultures" problem: humanists and scientists were not interested in understanding each other's concerns and ways of thinking. Consequently the two groups were unable to discuss with each other important public policy issues. Writing in the late 1950s, Snow saw the scientific illiteracy of humanists in the West as an obstacle to the scientific, technological, and economic development of the have-not nations.[6]

Others have focused on a different "two cultures" problems: the low level of science education achieved by the vast majority of U.S. citizens who drop out of school early or take every opportunity to avoid science and math courses. One

concern here is to "keep U.S. science strong" by recruiting more women and racial minorities into science careers as fewer and fewer white males enter the sciences. Another concern is the failure of the sciences to provide an adequate level of general science education to racial and ethnic minorities, women, and the working class. How can these groups make intelligent decisions about their own lives and the public policies that affect their lives—about their health, occupational safety, and environment, for example—when they lack scientific information and the ability to evaluate it (commodities that are all too difficult even for members of the privileged groups to obtain)? How can they participate fully in national and international decisions about such issues without scientific skills? An effective pursuit of democracy requires that those who bear the consequences of decisions have a proportionate share in making them.[7] The failure of the United States to distribute science educations democratically compromises its commitments to and competence at democracy.

These earlier concerns have by no means disappeared or become less important. But discussions of the new scientific illiteracy provide an enlarged perspective on them. Western sciences clearly have been and continue to be complicit with racist, colonial, and imperial projects. Not surprisingly, Westerners fail to situate their understandings of both nature and the sciences within maximally realistic and objective world histories. Full acknowledgment and analysis of these Eurocentric tendencies leads to the recognition that racially marginalized groups, at least, may have good reasons for avoiding sciences that have had undoubted good effects for those in positions to benefit from them but, nevertheless, in other respects appear to be effectively committed to increasing consumerism and profit, maintaining social control, and legitimating the authority of elites.[8] So the emerging understanding of the scientific illiteracy of the most highly educated groups contributes to a better understanding of the causes of one form of the earlier scientific illiteracy in the West. It must be noted also that in the Third World, science is often a means for individuals to escape marginalization and to join an international elite. The glamour and power of science co-opt as well as coerce.[9] Privileged classes in the Third World, too, are often concerned only to benefit themselves.

Fortunately, valuable resources have begun to appear from a number of diverse sources that can help to produce a more objective understanding of the nature and consequences of Western sciences in world communities—past, present, and future.

New Resources for Understanding the "Racial" Economy of Science

Anti-Eurocentric Movements

Around the world as well as in the West, new social movements have challenged the authority of the West to impose its values and standards on peoples with histories and present concerns that are opposed to those of privileged groups in

the West. All of the world's peoples bear the consequences of policies made in the West, but they do not get a fair share in making decisions that will have such powerful effects on their lives.

Scientific and technological issues often arise in these analyses. How and why are Western sciences implicated by these critiques? What would sciences and technologies look like that were designed *for* the majority of the world's peoples instead of only for already overadvantaged Westerners and Third World elites? Should there be many different but equal culturally specific sciences, or only one "world science"? Insightful responses to such questions are provided in many of the essays in this collection.

The New Social Studies of Science and Technology

Recent work in the social studies of science and technology also provides new resources. Of course scientist-historians such as J. D. Bernal and Joseph Needham as well as the radical science movement had long shown that the cognitive content of natural science claims has been coherent with the distinctive concerns of the cultures within which they have developed, not just with science traditions that have been imagined to be autonomous from their surrounding cultures.[10] Moreover, such influences on science have played important roles in the growth of scientific knowledge, not just in its retardation, as the conventional view claimed. Our best beliefs as well as our worst ones have social causes. Historians, sociologists, and anthropologists of science have pursued such arguments in greater detail more recently.[11]

The new gender-focused studies of science have provided especially insightful analyses of how social interests and values get into the cognitive content of the sciences, as a number of the authors in this collection point out. Even the least likely fields and aspects of science have turned out to bear the fingerprints of androcentric projects. Physics and logic, the prioritizing of mathematics and abstract thought, standards of objectivity, good method, rationality—all of these have been thought immune to social influences. And yet feminist critiques have revealed androcentric fingerprints even here—for example, in the mechanistic models of early modern astronomy and physics and in the coding of reason as part of ideal masculinity.[12] The feminist arguments help to clear the ground for asking similarly pointed questions about the racial and Eurocentric traces in such abstract areas of the sciences, and they provide valuable resources for such projects. Moreover, racism and Eurocentrism often appear in gender-specific forms. Furthermore, Third World cultures have their own legacies of androcentrism and sexism, as a number of Third World authors point out in these essays.

Diversity Concerns in Educational Institutions

There are now new audiences and resources for addressing these topics in every level of U.S. educational institutions. Elementary and high schools are increasingly concerned to provide more realistic and inclusive pictures of the world and of their students' lives. For one thing, the world is still shrinking; changes in the world community appear on television every day; increasing numbers of people in the United States have gotten to know people from other countries—either there or here. For another, the demographic "coloring" of America makes the shortcomings of Eurocentric educations even more obvious.

Many university administrators, faculty, and students are actively concerned to decrease the Eurocentrism that has marred their curricula, courses, research, and scholarship. No doubt some of this concern by administrators and faculty is self-serving. They want to create courses, curricula, and intellectual environments that will attract minority students in the United States who must become a larger proportion of the professionals of tomorrow, given the aging of the white population. They want to attract tuition monies from foreign students, since the pool of traditional U.S. students is shrinking. Moreover, in such fields as business, engineering, and international relations, there is a perceived need to train Western managers and administrators who are capable of interacting more effectively in international markets as they manage U.S. business and domestic and foreign relations in ways that will "keep America strong." Furthermore, these fields are happy to train foreign managers in U.S. ways of doing business.

These realities, however, should not distract us from appreciating the growing strength of the yearnings many Western people have not to be on the "wrong side" of history morally, politically, or scientifically. Many people want to act fairly and responsibly and to understand how nature and social relations really work in order to advance democracy. No one wants to have to confront the perception by others that he or she is irresponsibly ignorant or greedy. Most people do not want to find out that Eurocentric biases blocked their critical thinking and made them unintentionally responsible for increasing their own ignorance and for worsening conditions for the already worst off. The diversity concerns on campuses offer new resources for thinking about Western sciences and new audiences for such thoughts.

Reflexive Science Tendencies

The natural sciences themselves provide new resources and audiences for these topics. Of course, many natural scientists—of "first world" as well as Third World descent—have been the most persistent and illuminating critics of the "racial" economy of the sciences. Their numbers are increasing, and here as in other fields scientists express the same yearnings to learn how to locate themselves and their projects in more objective, more realistic, less chauvinistic understandings of local and international politics. There is an increasing recognition among scientists themselves that the economics and politics of science shape the results of research in the best as well as the worst moments in the sciences, that sciences tend toward their uses, that the sciences need to expand and transform their goals and methods of research if they are seriously to confront the fact that

"only that which is true to culture is true to nature." Even a National Academy of Sciences document now argues that the notion of scientific methods should be enlarged beyond its familiar meanings of "double-blind trials, randomization of experimental subjects, and the proper use of controls" and its obvious use of observational and intellectual tools.

> The term "methods" can be interpreted more broadly. Methods include the judgments scientists make about interpretation or reliability of data. They also include the decisions scientists make about which problems to pursue or when to conclude an investigation. Methods involve the ways scientists work with each other and exchange information.[13]

As this document goes on to point out, the way for scientists to avoid allowing social biases to distort their work is "by trying to identify their own values and the effects those values have on their science. One of the best ways to do this is by studying the history, philosophy and sociology of science. Human values change very slowly, and the lessons of the past remain of great relevance today."[14] Especially noteworthy here is the implication that the values most troublesome to identify are those shared by cultural communities—the ones that "change very slowly." Clearly many scientists are coming to understand that Western sciences have produced less than the maximally objective understandings of nature's regularities and their underlying causal tendencies and that it is possible and necessary to develop stronger standards of objectivity.

Science Education

Educators in the United States are now concerned to improve science education at every level in order to attract into the sciences and to retain more women and racial minorities. The older scientific illiteracy problem led to the improved design of many general science courses in order to educate humanists in the "mysteries of nature." And it led to various projects to recruit and retain in the sciences members of underrepresented groups. But neither project has made much effort to include the new histories and social studies of the sciences inside science courses and curricula. Being able to explain the regularities of nature and their underlying causal tendencies is inseparable from providing the same kinds of explanations of the social relations of science. Science education has suffered from its lack of attention to such phenomena as the "racial" economy of science, perhaps fearing that any but the most minimal admission of error in the past—such as the many cases discussed in this collection—would generate the accurate perception that not enough has been done to block such antidemocratic and ignorance-producing tendencies today. This "ostrich strategy," however, has lost its effectiveness. It is harder and harder to maintain the public fiction that U.S. science and technology policy at home and abroad is always—or even usually—right. This is an opportune moment to examine what changes should be made in

science education if a greater diversity of U.S. students are reasonably to perceive that U.S. sciences are for them and not primarily for militarism, consumerism, profit, and social control, and if all U.S. citizens more generally are to have good reasons to be proud of our sciences.

The Changing World Community

Last but not least is the timeliness of these issues for current attempts to figure out desirable social relations for the world community. It is scary to contemplate how the power that Western sciences and technologies make available is likely to result in increased destruction to humans and our environments—and especially to economically and politically marginalized humans and environments—unless this power can be harnessed quickly to work on agendas for more democratic world communities. What scientific and technological knowledge do the victims of Eurocentrism need in order to articulate and to achieve their best course within communities that resist democratization? What knowledge do well-intentioned members of dominant groups in the West need in order to understand the contemporary and historical locations from which their sciences have emerged, what they can and cannot do to decrease the partiality and distortion of their accounts of nature and social relations, and how to link the sciences more effectively to social justice agendas? These issues are too important to be left to scholars and scientists alone; increasingly they are recognized as issues for every citizen of the world.

Sciences in (and before) Eurocentric History; Eurocentric History in Sciences

Six topics have been selected as particularly useful for thinking further about these interests and needs.

Early Non-Western Scientific Traditions

With few exceptions, at least until recent decades, Westerners have sacrificed empirical and theoretical adequacy in order to promote the claims that the exemplary processes and achievements of "their" science prove that it is different in kind from those of any other cultures' knowledge seeking and that Western sciences and their technologies are the most important measures of human progress. These chauvinists insist that the development of modern sciences shows how progressive, rational, and civilized is the modern West in contrast to the backward, irrational, and primitive "rest."

It is clear, however, that the high cultures of China and Islam produced experimental sciences, mathematics, and technologies that were earlier and often

equal or, in some cases, superior to those of at least the early modern period in Europe. Moreover, Africa and the Americas were by no means left in "the primitive"; they too generated important scientific and technological advances that were earlier and superior to European achievements. For example, carbon steel was produced in what is now Tanzania some 1,500 years ago by methods of such sophistication that they were not matched in Europe until the nineteenth century.[15] Experimental agriculture apparently was developed in the Andes before the Columbian encounter. Its knowledge was appropriated by the European conquerors and recycled through European science, without acknowledgment of its origins. In other cases, non-Westerners have been kept ignorant of their culture's own achievements. As Michael Adas points out, British colonial administrators did not allow Indians to be taught their own contributions to mathematics.[16]

Moreover, as one scholar after another has noted, European sciences progressed primarily because of the military, economic and political power of European cultures, not because of the purported greater rationality of Westerners or the purported commitment of their sciences to the pursuit of disinterested truths.[17] If the success of these sciences required the military and political defeat of non-European peoples, we are entitled to skepticism about claims that the history of these sciences is unmitigatedly the history of *human* progress; progress for some has been at the expense of disempowerment, impoverishment, and sometimes genocide for many others. Finally, the world still can learn from these non-Western traditions; without nourishing the illusion that we can or should escape from the West into "elsewhere," we can recognize that the pool of valuable scientific ideas is not restricted to what has been produced by dominant groups in the West. In short, early non-Western science traditions need to be evaluated in more objective ways, and the Western traditions need to be more objectively situated in world history.

Science Constructs "Race"

A second useful focus is on how the sciences have actively participated in the construction of the category of "race." It has now been forty years since some biologists and physical anthropologists began to point out that the concept of race is incompatible with evolutionary theory. They have shown why population genetics should replace the concept of a fixed and discrete cluster of biological attributes as the empirically and theoretically adequate way to explain human variation. Moreover, it turns out that there is greater genetic variation within every "racial" group than there is between any two of them.

Yet scientists in such fields as biology, medicine, and public health still use this apparently anachronistic concept of race. Some still demand accounts of the biological basis for racial distinctions. In other cases, racially marked groups appeal to race differences on their own behalf—for example, when Native Americans demand treatment for their high rates of diabetes. Of course these high rates of diabetes should be eliminated. However, even though biologists know that it is population genetics that explains variations in the distribution of diabetes, the rhetorical use of racial categories codes race as fixed, and thus this dynamic ends up supporting the older notion of "the races."[18]

Another way to put this point is that race is socially constructed yet also "lived in";[19] it is manufactured yet also "material," as many essays in this collection demonstrate. Moreover, peoples of color appeal to their racial identities and their shared locations in material race relations in order to describe the conditions of their lives, and also to draw together and energize the victims of racism and Eurocentrism for emancipatory struggles. "Whites" can engage in similarly liberatory practices if they insist on the importance of speaking critically of racism and Eurocentrism from their objective location "as whites" in the social order. We live "as whites" in ways structured by real economic, political, and social relations; the fact that racial difference is socially constructed does not prevent it from having real, structural effects in society.

The histories of scientific constructions of race are especially revealing. For one thing, what now clearly appears as racist research often was conducted by the most distinguished scientists of the day. Moreover, these scientists were not all political regressives; some were in other respects among the most progressive white thinkers of their day on race issues. Clearly, racist and Eurocentric beliefs and practices cannot be attributed solely to "crackpots," to intentional racism, or to prejudices—bad attitudes and false beliefs—as the dominant liberal social theory would have it.

These histories also reveal various strategies that targets of scientific racism used to fight back. Especially important has been the use of socially legitimated discourses about nature that were alternative to those of the sciences—for example, religion.[20] Such lessons from the past draw attention to the radical potential of the emerging discourses on nature and on the sciences in the new social movements, in literary and cultural studies, and in other sites of reflection and debate that are outside the sciences themselves.

Who Gets to Do Science? Who Gets to Direct Science?

It should appear paradoxical that the natural sciences, with methods admired supposedly because they maximize the identification and elimination of social biases that researchers might bring into science, nevertheless have severely restricted the chance to direct science to elites or those with aspirations to join elites. Is it scientific method or restricting researchers primarily to white men that is supposed to be responsible for the (purported) value neutrality and universal validity of Western scientific claims?

Does the claim that science is more democratic than the social structure of the larger society get used as a tactic to exclude minorities from science, to placate those privileged few let into the top ranks of the sciences, and to keep the direction of the sciences firmly in the control of the overadvantaged groups in the West? Various proposals have appeared for increasing the numbers of minorities

in the sciences and for their more democratic participation in the direction of scientific research. Do these succeed in recognizing the full array of obstacles to achieving these goals? How should they be strengthened?

Science's Technologies and Applications

Are the sciences innocent when they or their technologies are used in racist and Eurocentric ways? Yes, according to the conventional view. And yet it has become increasingly clear in the last few decades that no sharp line can be drawn between "pure sciences" and their technologies and applications. Examining case studies of technologies and applications that have gone wrong reveals what is also wrong with the problematics, background assumptions, metaphors, research designs, interpretations of evidence, social environment, functions and purposes of the sciences that generated these applications and technologies.

Metatheory and Philosophy of Science

The widespread existence of racist and Eurocentric results of scientific research leads to questions about the adequacy of the metatheories and philosophies of science that have directed scientific practices, the social studies of the sciences, and popular beliefs about science. Should we go beyond the criticisms of specific bad consequences of the sciences to develop stronger standards of good method and of how to maximize objectivity than the only weak and ineffectual ones we have had? To the extent that culturewide beliefs are not critically identified, it is cultures, not individuals, who are the subjects of scientific knowledge. Do the sciences need a more adequate account of the subject or agent of knowledge?

Since science must use metaphors to extend and revise its theories, what should we think about the political regressiveness of some of the most widely used such metaphors—the Garden of Eden metaphors for "wild nature," for instance, or the rape metaphors for scientific method, and the feminine metaphors for racial "others"? If it is true that nature-as-an-object-of-knowledge is irretrievably social, as many argue, are the natural sciences usefully conceptualized as *social* sciences? Can we develop this idea without losing the ability to insist on the distinction between "natural facts" and people's perceptions of them? Clearly the metatheories and philosophies of the sciences need an even more thorough overhauling than the new social studies of science have imagined.

Visions and Strategies for the Future

Which sciences should we develop for a democratic world community? The answers to this question have tended to be either naïve or insufficiently ambitious. For example, they have assumed that it is possible to isolate and practice pure sciences and that there is no need to make changes in the Eurocentric and racist societies in which the pursuit of "value-neutral science" has been an integral part. Or they have focused on strategies for recruiting more racial minorities into the sciences and retaining them there without questioning the racism and Eurocentrism of the kinds of projects for which science is funded and on which racial minorities are supposed to want to work. Sometimes they have called for "sciences of our own"—alternative sciences that are *for* racial minorities and people in developing countries—without producing strategies for dealing with the ways in which access to scientific training and to the resources for research are firmly controlled by Western elites who clearly will try to block the development of, or to coopt, alternative sciences. Moreover, conceptualizing the project here as creating "alternative" sciences leaves Western sciences setting the standard for "real science."

Sometimes they have adopted a "forward to the past" posture, seeking to ground knowledge seeking for today in premodern world views and practices rather than in a critical winnowing of past and present practices. Frequently they have assumed that racist assumptions can be eliminated without also addressing androcentric and misogynous ones, although it is clear that "race" and gender, racism and sexism, construct and maintain each other, as they also do class oppression and heterosexism. Sciences free of racist and Eurocentric assumptions cannot be achieved apart from the elimination of the other social hierarchies into which they are firmly locked; sciences will be no more emancipatory than are the larger social agendas that nourish and guide knowledge seeking. But if we follow the important popular slogan "Think globally; act locally," what are the best ways to begin to transform the sciences? Which present practices and programs—in the West and "elsewhere"—should be supported and further developed?

Conceptual Challenges

Conceptual challenges arise in any attempt to identify and analyze the structure of Western science's involvement with projects of racism and Eurocentrism. Here are four that have already been mentioned and that have wide-reaching consequences for reflecting on the essays in this collection.

1. "Race," class, and gender form a matrix of privilege. Class and gender policies have constructed and maintained racial hierarchies just as race policies have done for class and gender hierarchies. Consequently, to understand race policies and projects, one must also understand how they both make use of and regenerate class and gender projects. Let us pursue this challenge in more detail.

First, it is important to keep in mind that the concept of race is constructed in at least three forms—individual, structural, and symbolic. It appears as a characteristic of individuals, of course. But it also appears as a characteristic of the structure of societies—some are more organized by racial hierarchies than are others. Thus South Africa, Nazi Germany, and the American South during and

after slavery, with their elaborate structures of racial classification and restrictions on which races can do which activities, simply *have* more race than do other less rigidly and comprehensively racially stratified societies. Moreover, race also appears as a symbolic system in which "black," "brown," "yellow," "red," and "dark" signify evil, ignorance, danger, and pollution and "white" and "light" signify good, knowledge, safety, and purity. Apparently this symbolic system was already in place in Europe in the Middle Ages.[21]

Moreover, these three aspects of race are sometimes in conflict with each other. Invocations of racial symbolism and stereotypes frequently increase just when race as a structural system is changing or is perceived to be weakening—for example, after the abolition of slavery in the United States and after the successes of the civil rights movement in the 1960s. It has been in these periods that projects of scientific racism accelerate their attempts to provide biological justifications for racist social structures and for meanings (symbols) of racial difference.

Gender and class hierarchies are interlocked with racial hierarchies in each of these three forms: individual, structural, and symbolic. Gender and class policies and projects construct different racial identities for women and men, rich and poor; different positions within a racial structure; and different meanings of race. In other words, in societies where "race" has been constructed, we each occupy a determinate race, class, and gender location in our society's matrix of social hierarchies, and each such location gives us an individual race, class, and gender, assigns us to different activities, and gives symbolic meanings to those identities and activities.[22] (Ethnicity, religion, and sexuality can provide additional significant dimensions to our social location.)

A number of good consequences can follow from recognizing that race functions as a part of a social matrix that is structured also by gender and class. It draws attention to the way whites, too, have a specific location in such a matrix and are perceived and even required to act in certain ways regardless of individual desires and intentions. I will always be treated as "white" (in a bank, at a philosophy conference, in a classroom, in a convenience store at midnight, walking on the street) and expected to make the kinds of assumptions characteristic of the dominant race (e.g., to accept "white" privileges, such as assuming that I will be regarded by any and every audience as qualified to speak about "women [race unspecified] and science").[23]Moreover, it draws attention to the way racial differences are always constructed by, and themselves construct, class and gender differences. My privileges as a "white" person are specific to my gender and class; for example, men of my race and class have different privileges than do I; "white" women of other classes are subject to different conditions and expectations. Much social theory mystifies the social order by assuming that race, gender, and class are parallel but fundamentally separate social systems. Matrix theory shows the importance of centering and problematizing their mutually constructing and interactive processes. It shifts attention from efforts to explain race, gender, and class as autonomous "things" to efforts to explain the flexible and dynamic relations between them.

To focus on race and science thus presents several challenges. First, when class, gender, and whatever other forms of stratification and social meaning in a particular society are not also clearly in focus, such an account can provide only a partial and, perhaps in some ways, distorted understanding of race, science, and their intersection. It is easy to forget this, since much of the otherwise most interesting literature in this field does not recognize the importance of focusing on gender or, sometimes, class dimensions of racial histories (as alert readers will notice in some of the essays in this collection). Furthermore, this argument about a "matrix of oppression" is itself controversial. Some thinkers believe that it is class agendas alone that have produced and that maintain today the forms of racism and sexism that we see in the world around us. For them, it will seem distorting and inappropriately limiting to center attention on "race and Western science" when, in their view, both are entirely products of attempts by Western economies to increase their profit and social control. Such objections should not be lightly dismissed, since these Marxist traditions have contributed comprehensive and illuminating descriptions and explanations of just how Western economies have contributed to scientific racism and imperialism—from biological determinism to ecological destruction and genocide. They continue to provide important analyses today.

In spite of these possible objections, there are good reasons to frame a project specifically about Eurocentrism, race, and science. For one thing, class and gender projects often appear in Eurocentric and racial forms and thus can usefully be examined in those terms. Since gender, race, and class construct each other, we can learn a great deal by centering racial concepts, histories, and contemporary agendas so as to discover where and how they are shaped by, and in turn shape, class, gender, and other social structures and meanings. Moreover, many thinkers hold that whatever their origins, racial phenomena exist today at least partially independent of agendas of class exploitation. They have come to have a life at least partially of their own.

Others have claimed a "post-Marxist position," noting that Marxist insights are now part of the intellectual inheritance of the contemporary West, whether or not this is recognized or used by all. From this perspective, the new social movements that result in science projects, such as contemporary feminist and antiracist ones, simply are post-Marxisms, not merely in the sense that they come after orthodox Marxism or reject its fundamental insights but also in the sense that they adapt and use Marxist understandings to describe and explain both different phenomena and later ones than orthodox Marxism was designed to illuminate.[24] From this perspective, the alternatives to post-Marxism are either anachronistic pre-Marxism or anachronistic antique Marxism.

The fact of the matter is that many peoples in the world choose to identify themselves not as raceless economic men but as members of racially exploited and marginalized groups or, for a small but increasing number, of Eurocentric and racially overadvantaged groups. Peoples of color have themselves asserted their own "racial" identities as a way to mobilize resistance to Western racism, and they have explored the alternative cultural identities and histories that were

rejected by Westerners, identities that have been developed as survival strategies and forms of resistance to racism and Eurocentrism. Moreover, many "whites" are making a project of learning to think and act out of their own particular "racial" historical social locations rather than assuming that their thoughts and actions are not at all shaped by these conditions from which they issue. They are trying to learn how to take responsibility for their racial position in history.

For these reasons, analyses focused on the Eurocentric and racist agendas that have directed Western sciences can provide resources for advancing both the sciences themselves and the social studies of science as well as more general democratic projects.

2. *Science is a contested zone.* In one sense, it is obvious that we cannot turn to today's sciences—the supposed models of Western objectivity and rationality—to resolve questions about the racism or imperialism of Western science, for it is exactly those sciences and beliefs about them that are on trial; it appears absurd to expect the "fox" to help us understand or judge the way he has "guarded the chicken coop." Their complicity with Eurocentric and racist projects is a regressive aspect of the sciences and popular belief.

But in another sense, it is exactly scientific procedures that have proved so effective in identifying racist and imperialist tendencies in the sciences, and it is in the name of greater objectivity and scientific rationality (as well as social justice) that alternative accounts are proposed. We want less partial and distorted descriptions and causal explanations—more scientific ones—of why and how Eurocentric assumptions and projects have shaped Western sciences, and of how to link scientific projects more firmly to democratic ones—the concerns of all of the authors in this collection. Moreover, scientists themselves have been in the forefront generation after generation in producing these criticisms and alternative accounts. The sciences also have a progressive history of opposition to Eurocentric and racist projects.

In short, science is a contested zone here, as it has been in other contexts and should be at its very best. Science is a terrain on which inherited social beliefs may be rigorously challenged and visions for the future debated. The Western scientific ethos as well as the history of scientific institutions and practices contains both progressive and regressive tendencies, and the societies that produce science have fought over who will control these resources. Antiracist and anti-Eurocentric projects intend to advance the progressive tendencies and block the regressive ones. What we should fear is not such discussions but their silencing. As Robert Proctor points out about Nazi medicine in his essay reprinted here, the depoliticization of science is always at least as dangerous as its inappropriate politicization.[25] So the goal of critics of racism and Eurocentrism is to make more democratic the political discussions of the sciences. That is, it is not to "politicize" the sciences but to prevent their dangerous depoliticization.

3. *"Pure science"? "Pure nature"?* Over fifty years of massive external funding of scientific research and development plus thirty years of the new social studies of science have made it virtually impossible to locate thoughtful observers of science who will even try to defend the view that there is such a thing as "pure

science" that can usefully be distinguished from its social origins, meanings, institutions, practices, technologies, and uses. With the collapse of this distinction, it is no longer possible to provide plausible arguments that there is any part of the scientific process that is in principle immune from responsibility for the bad consequences of Western sciences.

Too many science teachers and researchers in universities evidently have thought that they could point to their own ignorance of the origins and (predictable) consequences of their work as evidence of the purity of their work and the enterprise to which they recruit students. This planned ignorance of researchers and teachers has been encouraged partially through dividing between different groups of workers the tasks of selecting scientific problems, of producing information about nature, and of funding the sciences and generating applications and technologies from this information. This division of labor has helped to maintain the illusion that what is done in "pure research"—often located in university science departments—has nothing to do with the science policy constructed in governments and industries or with what goes on at the other end of science in engineering and medical research departments, industry, "development" projects, or military establishments. These days this illusion is virtually impossible to maintain as the "pure science" departments more and more come to depend on federal funding. Ignorance of the predictable uses of the results of scientific research is not evidence for science's purity.

There are a number of ways in which the purported autonomy of the cognitive content of the sciences is breached. For one thing, social and political problems are frequently redefined as technological or scientific ones. In other words, the origin of technological and scientific problems is always to be found partially in social and political problems.[26] Thus which scientific questions get asked depends largely upon who—which historically located social group—gets to do the asking. Should "the problem" be conceptualized as how to limit the reproduction of people of Third World descent or how to create a more egalitarian distribution at international as well as local levels of food, health resources, labor power, and other natural and social resources? Which scientific picture of this part of nature and social relations will be created depends on who gets to decide which question is to be answered.

Second, modern science is constituted at its very core as use oriented. Scientific experimentation privileges intervention in nature as the way to obtain reliable information. The usefulness of science for applications and technologies is not extrinsic to obtaining scientific information; instead it is the ethic directing the modern scientific enterprise and often claimed to distinguish it from earlier sciences.[27] Relatedly, science uses technologies to conduct research, and these technologies themselves carry social and political values. Galileo's telescope moved authority about the heavens from the church to anyone who looked through it. Today, sophisticated instruments require a more highly educated scientific work force, and decisions about who will gain access to such education, beginning in kindergarten and even in infancy, are political ones. As long as the United States tolerates such a low level of the general education upon which

scientific educations depend, people of Third World descent in the United States are unlikely to gain access to the sciences and their technologies. These sciences and technologies thereby become means of limiting democracy.

Furthermore, scientific projects have social and political meanings to the people who do them, to the societies that support them, and to those around the world who bear the consequences of these projects. Some would say that sciences simply *are* their meanings and uses. For example, they would point out that both the referents and the meanings of race-difference research will tend toward the uses of such research.

These are the kinds of arguments that make it difficult to defend the view that there is such a thing as "pure science." Of course this is not to deny that "pure curiosity" leads children into science educations and scientists into the forefronts of knowledge. But individual intentions do not determine the social functions of individual or institutional actions nor the uses that others have in mind for the results of their curiosity. It is structural and historical explanations of science that are needed, not explanations of individuals' motives.

If there is no such thing as "pure science," should we still believe in "pure nature," unsullied by human meanings and interventions? On one hand, of course, nature existed before the evolution of hominids to humans, and it sets constraints on the beliefs societies and individuals can hold and still manage to survive—humans will not be the last phenomenon to exit from the world. On the other hand, it doesn't set all that many constraints on human belief, as the anthropological and historical records demonstrate. It is obvious that even our best theories are always underdetermined by their evidence; they can never be "proved true" but are always only "not yet proved false." This line of argument does deny that what scientists observe, describe, or explain is "pure nature."

Scientists, like the rest of us, *can* observe only nature-as-an-object-of-knowledge. These objects of knowledge in significant respects are similar to the subject of knowledge—those who do the observing. The same kinds of social influences that shape knowers and their scientific projects also shape nature-as-an-object-of-knowledge. Most people would be willing to admit this similarity for the subjects and objects of social science research but would think it absurd to make such a claim for the natural sciences. After all, trees, rocks, planetary orbits, and electrons do not constitute themselves as historical actors. They existed before there were any human societies and no doubt will exist after them. What they are does not depend on what they think they are; they do not think or carry on any of the other activities that distinguish human communities from other constituents of the world around us. But this distinction turns out to be irrelevant to the point here, since scientists never can observe the trees, rocks, planetary orbits, or electrons in a state in which they are untouched by human activities or meanings. Instead, they are destined to observe something different but, hopefully, systematically related to nature apart from human perceptions: nature-as-an-object-of-knowledge.

Trees, rocks, planetary orbits, and electrons always appear to natural scientists only as they are already socially constituted in exactly some of the ways that humans and their communities are already constituted for the social scientist. Such objects are already in effect removed from "pure nature" into social life—they are social objects—by, first of all, the contemporary general cultural meanings that these objects have for everyone, including the entire scientific community.[28] They also become socially constituted through the shapes and meanings these objects gain for scientists because of earlier generations of scientific discussion about them. Scientists never observe nature apart from such traditions; even when they criticize some aspects of them they must assume others in order to carry on the criticism. They could not do science if they did not both borrow from and criticize these traditions. Their assumptions about what they see are always shaped by "conversations" they carry on with scientists of the past.

Additionally, scientists' own interactions with such objects also culturally constitute them: to treat a piece of nature with respect, violence, degradation, curiosity, or indifference is to participate in culturally constituting such an object of knowledge. In these respects, nature-as-an-object-of-knowledge simulates social life, and the processes of science themselves are a significant contributor to this phenomenon.

Last, critics point out that there is no "pure" residue separable from these meanings and uses once we note that the intended or claimed purity of scientific research itself is fully pregnant with diverse meanings and uses to scientists, science policymakers, and the rest of us who are—intentionally or not—science consumers. In physics, often held up as the paradigm of "pure science" in spite of its consistent history of service to militarism and industry, virtually no research is now funded which cannot be predicted to generate technologically and politically useful information, even though (or precisely because) the ignorance of the scientists who generate this information about its probable usefulness is carefully planned and cultivated.[29]

4. The need for "strong method" and "strong objectivity." In light of the disappearance of "pure science" and "pure nature," is scientific method, as conventionally conceptualized, strong enough to identify and eliminate distorting social interests and values from the results of research? Are the existing standards of objectivity strong enough to guide the development of scientific methods that are effective at achieving such goals?

It is scientific method that is supposed to maximize objectivity by guarding against the intrusion of obscuring and distorting social values into the results of research. But it is now widely recognized that scientific method has been "operationalized" both too narrowly and too broadly to achieve this goal. It has been operationalized too narrowly insofar as only the context of justification—the part of science where hypotheses are tested and evidence gathered for or against them—is guided by systematic methods of research. But if the selection of problems to pursue in the first place—the questions asked—shapes the picture of the world the sciences produce, then the "context of discovery," where hypotheses are selected and refined, must also be subject to systematic critical methodological controls. Many critics of the natural sciences argue that racist and Eurocentric political concerns shaped the questions the sciences have asked and

that this is why the results of such research have been racist and Eurocentric.[30] The sciences need a "logic of discovery" to deal with this problem; they need a systematic method for identifying assumptions that shape the selection of problems as "scientific" in the first place.

But method has also been operationalized too broadly, for it is clear that not all social interests and values deteriorate the objectivity of the results of research. Democratic values, ones that prioritize seeking out criticisms of dominant belief from the perspective of the lives of the least advantaged groups, tend to increase the objectivity of the results of research.[31] After all, conventional understandings of scientific method are relatively effective at identifying the social values and interests that differ between the members of a scientific community. That is exactly the goal of the directive that observations and experiments should be repeated by different groups of scientists. But values and interests shared by all or virtually all members of a scientific community are not easily detected by such methods. If a scientific community is restricted primarily to people of one race (or gender, class, ethnicity, or sexuality), or if its members share certain Eurocentric values regardless of their racial or geographic origins, it will be hard to detect racist or Eurocentric values. Thus the systematic activation of democracy-increasing interests and values—especially in representing diverse interests in the sciences when socially contentious issues are the object of concern—in general contributes to the objectivity of science; it is wrong to imagine that scientific method requires the elimination of all social values from scientific processes.[32] So scientific method has been operationalized too narrowly and too broadly, in different respects, to achieve the elimination of objectivity-damaging social values and interests.

As noted earlier, the dominant conception of objectivity is implicated in these damaging limits of scientific method. A stronger, more adequate notion of objectivity would require methods for systematically examining all of the social values shaping a particular research process, not just those that happen to differ between the members of a scientific community.[33] Social communities, not either individuals or "no one at all," should be conceptualized as the "knowers" of scientific knowledge claims. Culturewide beliefs that are not critically examined within scientific processes end up functioning as evidence for or against hypotheses.

Modern Western sciences have been constituted from their very beginnings by both democracy-enhancing and democracy-retarding values. In spite of its obvious hierarchical structure, the scientific community today is often still conceptualized as a community of equals where any member is supposedly entitled and encouraged to criticize others' claims. The results of research are claimed to be public property, available for anyone's scrutiny. Moreover, early modern science refused to separate the social good of science from its social projects, as later scientific communities did and as positivism insisted.[34] Obviously, these ideals today bear little relationship to the actual structure and practices of many parts of contemporary sciences.

My point is a different one, however; modern science also incorporates certain authoritarian elements left over from its origins in struggles with religion. It insists on the monologic voice characteristic of totalitarian rulers or of God. It adopts a religious attitude, both toward the "pure nature" it observes and toward its own activities, that rewards fanaticism and the idea of "true believers" who have a pipeline to the one true story about the world. It frequently exhibits a paranoia about the possibility of "outsiders" influencing science, conceptualizing them as "crackpots" and megalomaniacs all too manipulative in their appeal to the ignorant masses, who are imagined as all too ready to swarm up and overwhelm fragile reason.[35] And it conceptualizes scientists (and the mathematicians and philosophers who support their projects regard themselves similarly) as chosen people, as elites, as persons morally superior to the "average man"—and, it goes without saying, to women and to "barbarians and savages."

The criticisms of racism and Eurocentrism in the sciences reveal the need for stronger standards of objectivity and more effective—stronger—methods of research. "Strong objectivity" requires that scientists give the same kind of critical descriptions and explanations of the subject of scientific knowledge—the scientific community in the enlarged sense of those who generate scientific problems—that social scientists at their best give to the objects of their research. "Nativist" accounts of the sciences (or of nature) are not enough; "outsider" perspectives are required to achieve causal accounts.

Many additional challenges remain for thinkers embarking on the project of gaining a more objective understanding of Western sciences and their place in world histories. Only when Westerners recognize and accept the unattractive underside of science will the sciences no longer provide a haven for those who find that psychic dynamic useful to them as individuals who are members of dominant races, classes, or genders.

Meanwhile we can note that while "the truth" will not enable us to end oppressive social relations, less false beliefs are definitely the better kind to have when engaged in such a project. An examination of Western science's complicity with racist, imperialist, and Eurocentric projects enables us to gain a more critical, more scientific perspective on an important part of that Western "unconscious" and thus on the history some groups in the West and "elsewhere" have been busy making, and continue to attempt to make even as we read.

NOTES

1. Ludwik Fleck, *Genesis and Development of a Scientific Fact* (Chicago: University of Chicago Press, 1979 [1935]), 35; quoted by Ruth Hubbard in *The Politics of Women's Biology* (New Brunswick, N.J.: Rutgers University Press, 1990).

2. Since "Western science" has important origins in the scientific traditions of diverse cultures back through history and around the world (as many authors in this collection

point out), since it is now pursued in virtually every country around the world, and since referring to it as "Western" reinstates the West-East contrast that so many authors in this book are trying to undermine, I should refer to it in some other way—perhaps as "international science." Doing so, however, loses an important focus on the Eurocentrism entrenched in "Western sciences," and it also introduces a term that evidently no other author in the book has found useful. Consequently, I shall stick with this problematic term. Readers should understand it as always in "scare" quotation marks—"Western" science—that is, as a social construct of Eurocentrism.

3. Walter Rodney, *How Europe Underdeveloped Africa* (Washington, D.C.: Howard University Press, 1982); Manning Marable, *How Capitalism Underdeveloped Black America* (Boston: South End Press, 1983).

4. There is no uncontroversial shorthand to use in referring to the complicity of Western sciences in projects of racism/ethnocentrism/Eurocentrism/colonialism/imperialism. Moreover, one cannot separate these issues from those of class and gender in the sciences any more than in any other area of social life. Note that when the term *race* is used here, it is always to be understood as a social construction—as "race."

5. Conversations with Donna Haraway lead me to put the issue this way.

6. C. P. Snow, *The Two Cultures: And A Second Look* (Cambridge: Cambridge University Press, 1964; part 1 first published in 1959).

7. John Dewey puts the point this way in *Democracy and Education* (New York: Macmillan, 1961).

8. As for the humanists, are they repelled among other reasons, by the hostility to the projects of the humanities, the simplistic conception of representing reality and the refusal of a critical reflexivity that are endemic in the sciences and so much of the social studies of science?

9. I thank Francesca Bray for pointing this out.

10. J. D. Bernal, *Science in History* (Cambridge, Mass.: MIT Press, 1971); Joseph Needham, *The Grand Titration: Science and Society in East and West* (Toronto: University of Toronto Press, 1969) (see excerpt in this volume); and Joseph Needham, with the collaboration of Wang Ling (Wang Ching-Ning), Lu Gwei-Djen, Ho Ping-Yu, Kenneth Robinson, Tshao Thien-Chhin, and others, *Science and Civilization in China* (seven volumes in twelve parts), Cambridge: Cambridge University Press, 1954). Two journals that give a good sense of the diversity in the radical science movement are *Science for the People* (now, unfortunately, no longer publishing) and the more recent *Science as Culture* (26 Freegrove Rd., London N7 9RQ, England).

11. For example, see Barry Barnes, *Interests and the Growth of Knowledge* (Boston: Routledge & Kegan Paul, 1977); David Bloor, *Knowledge and Social Imagery* (London: Routledge & Kegan Paul, 1977); Donna Haraway, *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (New York: Routledge, 1989), Evelyn Keller, *Reflections on Gender and Science* (New Haven, Conn.: Yale University Press, 1984); Bruno Latour and Steve Woolgar, *Laboratory Life: The Social Construction of Scientific Facts* (Beverly Hills, Calif.: Sage, 1979); Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (New York: Harper & Row, 1980); and Andrew Pickering, ed., *Science as Practice and Culture* (Chicago: University of Chicago Press, 1992). There have been many more important works in these veins. Jerome Ravetz's *Scientific Knowledge and Its Social Problems* (New York: Oxford University Press, 1971) and Thomas Kuhn's *Structure of Scientific Revolutions* (2d ed.) (Chicago: University of Chicago Press, 1970) were important in generating the more recent studies.

12. E.g., see the works by Haraway, Keller, and Merchant (n. 11); Susan Bordo, *The Flight to Objectivity* (Albany: State University of New York Press, 1987); Sandra Harding and Merrill Hintikka, eds., *Discovering Reality: Feminist Perspectives on Epistemology, Metaphysics, Methodology and Philosophy of Science* (Dordrecht: Reidel, 1983); Alison Jaggar, "The Role of the Emotions in Knowledge," in *Gender/Body Knowledge*, ed. Alison Jaggar and Susan Bordo (New Brunswick, N.J.: Rutgers University Press, 1989); Elizabeth Lloyd, *The Man of Reason: Male and Female in Western Philosophy* (Minneapolis: University of Minnesota Press, 1984); Andrea Nye, *Words of Power: A Feminist Reading in the History of Logic* (Boulder, Colo.: Westview Press, 1989); Londa Schiebinger, *The Mind Has No Sex: Women in the Origins of Modern Science* (Cambridge, Mass.: Harvard University Press, 1989).

13. National Academy of Sciences, *On Being a Scientist* (Washington, D.C.: National Academy of Sciences Press, 1989), 5–6.

14. Ibid., 8.

15. Debra Shore, "Steel Making in Ancient Africa," in Ivan Van Sertima, ed., *Blacks in Science: Ancient and Modern* (New Brunswick, N.J.: Transaction Books, 1986).

16. Jack Weatherford, *Indian Givers: What the Native Americans Gave to the World* (New York: Crown, 1988). Michael Adas, *Machines as the Measure of Men: Science, Technology and Ideologies of Western Dominance* (Ithaca, N.Y.: Cornell University Press, 1989). I thank Evelynn Hammonds for drawing this example to my attention.

17. See, e.g., Margaret Jacob, *The Cultural Meanings of the Scientific Revolution* (New York: Knopf, 1988), 251; Paul Forman, "Behind Quantum Electronics: National Security as Bases for Physical Research in the U.S., 1940–1960," *Historical Studies in Physical and Biological Sciences* 18 (1987), and many of the essays in Ziauddin Sardar, ed., *The Revenge of Athena: Science, Exploitation and the Third World* (London: Mansell, 1988).

18. I thank Anne Fausto-Sterling for this example.

19. I thank Donna Haraway for putting the point this way. See also Michael Omi and Howard Winant, *Racial Formation in the United States* (New York: Routledge and Kegan Paul, 1986).

20. Nancy Leys Stepan and Sander L. Gilman, "Appropriating the Idioms of Science: The Rejection of Scientific Racism," in Dominick La Capra, *The Bounds of Race: Perspectives on Hegemony and Resistance* (Ithaca, N.Y.: Cornell University Press, 1991), reprinted in this collection. See also Cynthia Eagle Russett, *Sexual Science: The Victorian Construction of Womanhood* (Cambridge, Mass.: Harvard University Press, 1989).

21. Winthrop Jordan, *White over Black: American Attitudes toward the Negro: 1550–1812* (Baltimore: Penguin, 1969).

22. See, e.g., Gisela Boch, "Racism and Sexism in Nazi Germany: Motherhood, Compulsory Sterilization, and the State," *Signs* 8, no. 3 (1983); Patricia Hill Collins, *Black Feminist Thought: Knowledge, Consciousness and the Politics of Empowerment* (Boston: Routledge, 1991); Bonnie Thornton Dill, "Race, Class, and Gender: Prospects for an All-Inclusive Sisterhood," *Feminist Studies* 9 (1983); Bell Hooks, *Feminist Theory: From Margin to Center* (Boston: South End Press, 1983); Elizabeth Spelman, *Inessential Woman: Problems of Exclusion in Feminist Thought* (Boston: Beacon Press, 1988); Maxine Baca Zinn et al., "The Costs of Exclusionary Practices in Women's Studies," *Signs* 11, no. 2 (1986).

23. See Peggy McIntosh, "White Privilege and Male Privilege: A Personal Account of Coming to See Correspondences through Work in Women's Studies," in *Race, Class, and Gender: An Anthology*, ed. Margaret L. Andersen and Patricia Hill Collins (Belmont, Calif.: Wadsworth, 1992).

24. E.g., see Ernesto Laclau and Chantal Mouffe, *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics* (London: Verso, 1985).

25. Robert Proctor, "The Politics of Knowledge," chap. 10 of *Racial Hygiene: Medicine under the Nazis* (Cambridge, Mass.: Harvard University Press, 1988).

26. "Partially," because scientific traditions (themselves fully social and political) also contribute to identifying which problems will get defined as scientific ones.

27. Hilary Rose and Steven Rose, "The Incorporation of Science," in *Ideology of/in the Natural Sciences*, ed. Hilary and Steven Rose (Cambridge, Mass.: Schenkman, 1979).

28. See Merchant's discussion (cited in n. 11) of the meanings of organicism and mechanism in the early modern period in Europe; Donna Haraway's discussion (in this collection) of differences in the ways Anglo-American and Japanese primatology communities conceptualize nature; Lezek Kolakowski's description of the political and social values

carried by Copernican and Galilean astronomy in *The Alienation of Reason: A History of Positivist Thought*, trans. N. Guterman (Garden City, N.Y.: Anchor Books, 1969); and Linnaeus's classification of minerals with living matter in his *Systema Natura* (I thank Anne Fausto-Sterling for this last example).

29. See Forman (cited in n. 17).

30. As we saw, the National Academy of Sciences proposes that scientific method should be construed far more broadly than popularly imagined. It should be noted that its agenda is not mine; it is concerned to protect scientific property from devaluation due to reports of experimental fraud, plagiarism, patent stealing, and the like.

31. This is the argument of standpoint theories of knowledge that trace their intellectual history back to Hegel's reflection on how much more comprehensive and less distorted is the understanding of the master-slave relation from the perspective of the slave's activities than from the master's. For example, from the perspective of the slave's activities, one can see that the slave is a human agent, trying to escape the lash, dissembling and forcing a smile on her face to hide her bitterness and anger, and so forth. From the perspective of the master's activities, everything the slave does appears to flow from the slave's "nature" or the master's will. See Nancy Hartsock, "The Feminist Standpoint: Developing the Ground for a Specifically Feminist Historical Materialism," in Harding and Hintikka, *Discovering Reality*, (cited in n. 12); Dorothy Smith, *The Everyday World as Problematic: A Sociology for Women* (Boston: Northeastern University Press, 1987); and chap. 5 of my *Whose Science? Whose Knowledge? Thinking from Women's Lives* (Ithaca, N.Y.: Cornell University Press, 1991) for a discussion of this alternative epistemology.

32. Of course, the term *democracy* is itself a contested zone, with different groups struggling to restrict or expand its meanings and uses according to their own purposes. Dominant groups frequently like to insist on only a kind of caricature definition of democracy: science policy committees consisting of one scientist from each state, as one person sarcastically proposed to me. A stronger statement of democratic procedures would be the one mentioned earlier: that those who bear the consequences of decisions should have a proportionate share in making them. Also, the argument here is not that democratic decision making should substitute for sound scientific decisions but rather that in many respects the latter will improve by attempts to institute the former.

33. I have proposed a notion of "strong objectivity" and of "strong method" in *Whose Science? Whose Knowledge?* and in other essays. See also my *Science Question in Feminism* (Ithaca, N.Y.: Cornell University Press, 1986).

34. Cf. W. Van den Daele, "The Social Construction of Science," in *The Social Production of Scientific Knowledge*, ed. E. Mendelsohn, P. Weingart, and R. Whitley (Dordrecht: Reidel, 1977).

35. These dangerous outsiders are frequently gender coded feminine; the scientific "knower" is conceptualized as the model of the rational, power-indifferent, individual, male hero struggling to establish and maintain order against the unruly hordes driven by irrational passions and desires for power. See the discussions in Bordo, Jaggar, Keller, Lloyd and Merchant cited earlier (nn. 11 and 12).

PART ONE

Early Non-Western Scientific Traditions

The discovery of primitiveness was an ambiguous invention of a history incapable of facing its own double.

V. Y. Mudimbe, *The Invention of Africa*

It is true that in modern Western culture, the theoretical models propounded by the professional scientists do, to some extent, become the intellectual furnishings of a very large sector of the population. . . . But the layman's ground for accepting the models propounded by the scientists is often no different from the young African villager's ground for accepting the models propounded by one of his elders. In both cases the propounders are deferred to as the accredited agents of tradition. . . . For all the apparent up-to-dateness of the content of his world-view, the modern Western layman is rarely more "open" or scientific in his outlook than is the traditional African villager.

Robin Horton, "African Traditional Thought and Western Science"

Resistance to the critique of Eurocentrism is always extreme, for we are here entering the realm of the taboo. The calling into question of the Eurocentric dimension of the dominant ideology is more difficult to accept even than a critical challenge to its economic dimension. For the critique of Eurocentrism directly calls into question the position of the comfortable classes of this world.

Samir Amin, *Eurocentrism*

Columbus's attitude with regard to the Indians is based on his perception of them. We can distinguish here two component parts, which we shall find again in the following century and, in practice, down to our own day in every colonist in his relations to the colonized. . . . Either he conceives the Indians (though without using these words) as human beings altogether, having the same rights as himself; but then he sees them not only as equals but also as identical, and this behavior leads to assimilationism, the projection of his own values on the others. Or else he starts from the difference, but the latter is immediately translated into terms of superiority and inferiority (in his case, obviously, it is the Indians who are inferior). What is denied is the existence of a human substance truly other, something capable of being not merely an imperfect state of oneself. These

two elementary figures of the experience of alterity are both grounded in egocentrism, in the identification of our own values with values in general, of our *I* with the universe—in the conviction that the world is one.

Tzvetan Todorov, *The Conquest of America*

Western histories of science conventionally have told the story of human scientific and technological achievements as one only about the modern West. They sometimes acknowledge that other peoples have produced technological achievements, such as the Egyptian pyramids, and that medieval Arabic mathematics was highly advanced. Little more needs to be said about non-Western scientific traditions, they assume. The roots of modern science are to be found in ancient Greece, they say, and modern science is uniquely an accomplishment of the modern West. In fact, according to its enthusiasts, it is *the* most distinguished of the West's many distinguished contributions to human progress: "who could deny that Newton's achievement is evidence that pure science exemplifies the creative accomplishment of the human spirit at its pinnacle?"[1] This kind of Western chauvinism has been used by generations of Western observers of non-Western peoples to claim that it is the ability to produce scientific thought that distinguishes the modern West from what they see as these barbarian, primitive, or underdeveloped cultures.

Without diminishing the brilliance or importance of modern Western science, a reevaluation has been emerging recently of the causes of its development, of its parallels and contrasts with independently valuable scientific traditions of other societies, of its debts to them, and of the adequacy of the common assumption that this Western science contributed only to "human progress" and not also at least equally to the de-development, the regress, of the Third World as well as of certain groups in the West. The three selections included in this section focus not only on the scientific traditions of three non-Western cultures but also on three Eurocentric strategies for devaluing them: deny that these achievements are really science; rewrite the history of the origins of European "civilization" to make it self-generating; and, through conquest, appropriate others' knowledge, recycle it as Western, and suppress knowledge of its origins.

In the 1950s Joseph Needham, a British scientist, began to publish accounts of the sciences and technologies of the Chinese high cultures and of the importance to the development of European sciences of the discoveries and inventions that Europeans borrowed from China but rarely acknowledged. In the essay here, he contrasts the "poverties and triumphs" of Chinese science with Western sciences and shows what's wrong with leading Western histories of science that are obsessed with establishing the uniqueness of Western sciences at the expense of the empirical and theoretical adequacy of their accounts.

The second selection is from Martin Bernal's *Black Athena: The Afroasiatic*

Roots of Classical Civilization. In the first of a projected three-volume study, Bernal focuses on what he calls the fabrication of ancient Greece between 1785 and 1985. He argues in the chapters reprinted here that it is no accident that "the Aryan model" of the origins of Greek civilization—the model "which most of us have been brought up to believe"—was developed to replace "the ancient model" in the early nineteenth century. Counter to the views held in the ancient world itself and on up until the late eighteenth century, the Aryan model introduced the idea that Africans and Semites had nothing to do with the creation of the classical Greek civilization, which modern European science claimed as its origin.[2] "For eighteenth- and nineteenth-century Romantics and racists," Bernal writes, "it was simply intolerable for Greece, which was seen not merely as the epitome of Europe but also as its pure childhood, to have been the result of the mixture of native Europeans and colonizing Africans and Semites. Therefore the Ancient Model had to be overthrown and replaced by something more acceptable." Moreover, the selection notes that for complex reasons Newton and Boyle were involved in creating and disseminating this revisionist history of the origins of modern European civilization. Thus the spread of Newtonian science also disseminated the Aryan model.

The discourse Bernal sets out to undermine had been contested by African and African American writers since the nineteenth century. This earlier and ongoing resistance to the Aryan model has largely been ignored by white Western scholars. Moreover, it is important to note that it is only through the work of Muslim scholars from Spain, the Middle East, and North Africa in the Middle Ages that the classical Greek tradition was transmitted to modern Europe. Finally, we need to question the notion of "civilization," with its insistent division of cultures into advanced and backward ones, that still is the focus of this important analysis. If we problematize that notion, we can gain a more balanced understanding of the outstanding accomplishments of simpler societies and a more objective grasp of the limitations of complex ones.[3]

Anthropologist Jack Weatherford reports on the immense improvement of the nutrition of Europe and many other parts of the world made possible by the agricultural experiments of the ancient Peruvians, and especially by their development of over three thousand varieties of potatoes that would grow under different ecological conditions. Eurocentric historians fail to describe the process that Weatherford reveals by which European conquests of the Americas appropriated the scientific and technological knowledge of the indigenous peoples and recycled it back through European and U.S. sciences, suppressing awareness of its sources in the Americas.

These and other histories have made it perfectly clear that the peoples responsible for modern science have come from many parts of the world; "the West" has always been a multicultural creation. So-called European sciences have incorporated and learned from many of these earlier traditions. As historian Eric R. Wolf observes, "the world of humankind constitutes a manifold, a totality of interconnected processes, and inquiries that disassemble this totality into bits and then fail to reassemble it falsify reality."[4] Furthermore, those scientific tradi-

tions that never left their traces in modern Western science are nevertheless interesting and important parts of the history of world sciences. As Tzvetan Todorov points out in the epigraph opening this section, it is time for Westerners to give up the egocentrism that propels us to obliterate the human other.

Moreover, the advance of European sciences and, in many cases, the decline of Third World scientific traditions have been caused in large part by European military, economic, and political conquests.[5] In Eurocentric histories these events are presented as the highest achievements of Europe's "civilizing" mission. In this scheme, the sciences and technologies of non-Western societies must be conceptualized as primitive in order to demonstrate the progress and success of the West. The authors in this section challenge this story.

Is Western science the only modern science possible and desirable? Do not modern Westerners define science—"real science"—too narrowly, as Needham argues, thereby devaluing forms of scientific thought and activity simply because they were or are not the forms favored in the sciences most useful to dominant groups in the modern West? What contributions do these older scientific traditions promise for the contemporary world? As some of the essays in section VI argue, perhaps we should think of these other sciences as providing diversity in the pool of scientific thought from which innovative, adaptable, and sturdy sciences can be developed for less war-loving and greedy societies of the future.

NOTES

1. I. B. Cohen, *The Birth of a New Physics* (New York: Doubleday, 1960), 189–90.

2. Afroasiatic elements were introduced a second time into early modern European science when Bruno and others drew on ancient Egyptian concepts and themes. In a later chapter Bernal goes on to point out that the peoples living in what is now Egypt looked far more "African" and less Semitic in the past than they do today.

3. E. Frances White makes these points in her review of Bernal's book, "Civilization Denied: Questions on *Black Athena*," in *Radical America*, vol. 21, no. 5 (1987), 38–40. For important discussions by scholars of African descent of the origins of Greek culture, see Cheikh Anta Diop, *The African Origin of Civilization: Myth or Reality?*, trans. M. Cook (Westport, Conn.: L. Hill, 1974); George G. M. James, *Stolen Legacy* (New York: Philosophical Library, 1954); and Yosef Ben Jochannan, *Black Man of the Nile, Africa, Africa the Mother of Civilization* (New York: Alkebu Lan Books, 1971). For guides to Islamic scientific achievements, see, e.g., I. A. Sabra, "The Scientific Enterprise," in B. Lewis, ed. *The World of Islam* (London: 1976); George Sarton, *Introduction to the History of Science*, 3 vols. (Baltimore: Johns Hopkins University Press, 1927–48); the *MAAS Journal of Islamic Science*; and the *Journal of Arabic Science and Philosophy*. Reports of early African scientific and technological achievements can be found in *The Journal of African Civilizations*. See Lacinay Keita, "African Philosophical Systems: A Rational Reconstruction," *Philosophical Forum 9*, nos. 2–3 (1977–78), for an account of the intellectual interactions between Asia, Africa, and Europe from the classical Greek thinkers through the European Renaissance that have made what peoples of European descent think of as Western thought in fact truly multicultural. In "Blaspheming Like Brute Beasts: Multiculturalism in Historical Perspective," *Contention*, vol. 1, no. 3 (Spring 1992), A. E. Barnes provides an illuminating account of the importance and long history of multiculturalism in Europe.

4. Eric R. Wolf, *Europe and the People without History* (Berkeley: University of California Press, 1982), 3. Evelynn Hammonds's comments greatly improved my thinking in this introduction.

5. See the papers in Patrick Pettijean, Catherine Jami, and Anne Marie Moulin, eds., *Science and Empires: Historical Studies about Scientific Development and European Expansion* (Dordrecht: Kluwer, 1992) in addition to many of the sources cited in the editor's introduction.