Ten Propositions on Science and Antiscience

Richard Levins

Since radicals began to look to science as a force for emancipation, Marxists both as social critics and as participating scientists have grappled with its contradictory nature. Because there is such a rich diversity of Marxist thought about science, I cannot claim that what follows is "the" Marxist position. I only offer in schematic form some propositions about science that have guided the work of at least this Marxist scientist.

(1) All knowledge comes from experience and reflection on that experience in the light of previous knowledge. Science is not uniquely different from other modes of learning in this regard.

What is special about our science is that it is a particular moment in the division of labor in which resources, people, and institutions are set aside in a specific way to organize experience for the purpose of discovery. In this tradition a self-conscious effort has been made to identify sources and kinds of errors and to correct for capricious biases. It has often been successful. We have learned to be alert to the possible roles of confounding factors and to the need for controlled comparison; we have learned that correlation does not mean causation and that the expectations of the experimenter can affect the experiment; we have also learned how to wash laboratory glassware to avoid contaminants and how to extract trends and distinctions from morasses of numbers. Our self-consciousness reduces certain kinds of errors but in no way eliminates them, nor does it protect the scientific enterprise as a whole from the shared biases of its practitioners.

On the other hand, so-called traditional knowledge is not static or unthinking. Africans (probably mostly women) brought as slaves to the Americas quickly developed an Afro-American herbal medicine. It was put together partly from remembered knowledge of plants found both in Africa and in America, partly from borrowed Native American plant lore, and partly from experimenting on the basis of African rules about what medicinal plants should be like. The teaching of traditional medicine always involves experimenting, even when it is presented as the transmission of preexisting knowledge. Finally, the criteria for prescribing various herbal therapies in non-European/North American medicine are probably better grounded than those that guide decisions about cesarean sections,

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pacemaker implants, or radical mastectomies in U.S. scientific medical practice.

Even what is described as intuitive (as against intellectual) knowledge comes from experience: our nervous/endocrine system is a marvelous integrator of our rich, complex histories into a holistic grasp that is unaware of its origins or constituents. Scientific and intuitive knowledge are not fundamentally different epistemologically; they differ instead in the social processes of their production and are not mutually exclusive. In fact, one of my goals in teaching mathematics to public health scientists is to educate the intuition, so that the arcane becomes obvious and even trivial, and complexity loses its power to intimidate.

(2) All modes of discovery approach the new by treating it as if it were like the old. Since it often is like the old, science is possible. But the new is sometimes quite different from the old; when simple reflection on experience is not enough, we need a more self-conscious strategy for discovery. Then creative science becomes necessary. In the long run we are bound to encounter novelty stranger than we can imagine, and previous well-grounded ideas will turn out to be wrong, limited, or irrelevant. This holds true in all cases, in both modern and traditional, class-ridden, and nonclass societies. Therefore, both modern European/North American science and the knowledges of other cultures are not only fallible but are guaranteed to err eventually.

To call something "scientific" does not mean that it is true. Within my lifetime, scientific claims such as the inertness of the "noble gases," the ways in which we divide up living things into major groupings, views as to the antiquity of our species, models of the nervous system as a telephone exchange, expectations as to the long-term outcomes of differential equations, and notions of ecological stability have all been overturned by new discoveries or perspectives. And major technical efforts based on science have been shown to lead to disastrous outcomes: pesticides increase pests; hospitals are foci of infection; antibiotics give rise to new pathogens; flood control increases flood damage; and economic development increases poverty. Nor can we assume that error belongs to the past and that now we've got it right—a kind of "end of history" doctrine for science. Error is intrinsic to actually existing science. The present has no unique epistemological status—we just happen to be living in it.

Therefore, we have to consider the notion of the "half-life" of a theory as a regular descriptor of the scientific process and even be able to ask (but not necessarily answer), "Under what circumstances might the second law of thermodynamics be overthrown?"

(3) All modes of knowing presuppose a point of view. This is as true of other species as of our own. Each viewpoint defines what is relevant in

the storm of sensory inputs, what to ask about the relevant objects, and how to find answers.

Viewpoint is conditioned by the sensory modalities of the species. For instance, primates and birds depend overwhelmingly on vision. With visual information objects have sharply differentiated boundaries. But that is not the case when odors are the major type of information, as for ants. An anoline lizard sees moving objects as being the right size to eat or as representing danger. A female mosquito perceives an academic conclave as gradients of carbon dioxide, moisture, and ammonia that promise blood meals, while a sea anemone trusts that glutathione in the water is enough reason to thrust out its tentacles in expectation of a meal. The fact that we live on the surface of the earth makes it seem natural to focus our astronomy on planets, stars, and other objects while ignoring the spaces between them. The timescale of our lives makes plants seem unmoving until time-lapse photography makes their changes apparent. We interact most comfortably with objects on the same temporal and size scales as our own and have to invent special methods for dealing with the very small or very large, the very fast or very slow.

(4) A point of view is absolutely essential for surviving and making any sense of a world bursting with potential sensory inputs. Much of learning is devoted to defining the relevant and determining what can be ignored. Therefore, the appropriate response to the discovery of the universality of viewpoints in science is not the vain attempt to eliminate viewpoint but the responsible acknowledgment of our own viewpoints and the use of that knowledge to look critically at our own and each others' opinions.

(5) Science has a dual nature. On the one hand, it really does enlighten us about our interactions with the rest of the world, producing understanding and guiding our actions. We really have learned a great deal about the circulation of the blood, the geography of species, the folding of proteins, and the folding of the continents. We can read the fossil records of a billion years ago, reconstruct the animals and climates of the past and the chemical compositions of the galaxies, trace the molecular pathways of neurotransmitters and the odor trails of ants. And we can invent tools that will be useful long after the theories that spawned them have become quaint footnotes in the history of knowledge.

On the other hand, as a product of human activity, science reflects the conditions of its production and the viewpoints of its producers or owners. The agenda of science, the recruitment and training of some and the exclusion of others from being scientists, the strategies of research, the physical instruments of investigation, the intellectual framework in which problems are formulated and results interpreted, the criteria for a suc-

cessful solution to a problem, and the conditions of application of scientific results are all very much a product of the history of the sciences and associated technologies and of the societies that form and own them. The pattern of knowledge and ignorance in science is not dictated by nature but is structured by interest and belief. We easily impose our own social experience onto the social lives of baboons, our understanding of orderliness in business, implying a hierarchy of controllers and controlled, onto the regulation of ecosystems and nervous systems. Theories, supported by megalibraries of data, often are systematically and dogmatically obfuscating.

Most analyses of science fail to take into account this dual nature. They focus on only one or the other aspect of science. They may emphasize the objectivity of scientific knowledge as representing generic human progress in our understanding. Then they dismiss the obvious social determination and the all-too-familiar antihuman uses of science as "misuses," as "bad" science, while keeping their model of science as the disinterested search for truth intact.

Or else they use the growing awareness of the social determination of science to reject its claims to any validity. They imagine that theories are unrelated to their objects of study and are merely invented whole cloth to serve the venal goals of individual careers or class, gender, and national domination.

In stressing the culture-boundedness of science, these analyses ignore the common features of Babylonian, Mayan, Chinese, and British astronomies and their calendars. Each comes from a different cultural context but looks at (more or less) the same sky. They recognize years of the same length, notice the same moon and planets, and calculate the same astronomical events by very different means.

Social determinists also ignore the parallel uses of medicinal plants in Brazil and Vietnam, the namings of plants and animals that roughly correspond to what we label as distinct species. All peoples seek healing plants and tend to discover similar uses for similar herbs.

Other traditions than our own also have their social contexts. Babylonian priests or Chinese administrators were not bourgeois liberals, but for all that they were not wiser or freer from viewpoint. Nor does the phrase "the ancients say" tell us anything about the validity of what they say. Ancients like moderns belong to genders, sometimes to classes, always to cultures, and they express those positions in their viewpoints. Those ancients whose thought has been preserved in writing were also not a random sample of ancients.

But to be socially determined and conditional on viewpoint does not mean arbitrary. While all theories are eventually wrong, some are not even temporarily right. The social determination of science does not imply a

defense or toleration of the patently false doctrines of racial or gender superiority or even the categories of race themselves, whether in the conventional academic forms or the "Adamic man" and the "mud people" of the Christian Identity Movement. Racism is a more real object than race and determines the racial categories.

Therefore, the task of the analyst of science is to trace the interactions and interpenetrations of intellectual labor and the objects of that labor under different conditions of labor and under different social arrangements. The art of research is the sensitivity to decide when a useful and necessary simplification has become an obfuscating oversimplification.

(6) Modern European/North American science is a product of the capitalist revolution. It shares with modern capitalism the liberal progressivist ideology that informs its practice and that it helped to mold. Like bourgeois liberalism in general it is both liberated and dehumanized. It proclaimed universal ideals that it did not quite mean, violated them in practice, and sometimes revealed those ideals to be oppressive even in theory.

Therefore, there are several kinds of criticisms of science. A conservative criticism inherits the precapitalist critique. It is troubled by the challenge that scientific knowledge poses to traditional religious beliefs and social rules and rulers, does not approve of the independent judgment of ideas and values, does not demand evidence where authority has already pronounced, and therefore is disturbed mostly by the radical side of science. Creationists quite accurately identify the ideological content of science, which they label secular humanism, against the liberal formula that science is the neutral opposite of ideology. But no matter how much they search the scientific journals for evidence of conflicts among evolutionists and weak spots in modern evolutionary theory, their challenge is not to make science more "scientific," more democratic, less bound by oppressive ideology, and more open. Rather they propose to return to faith, to the more obvious kinds of authority, and to anti-intellectual certainties. Their gut-level anti-intellectualism is often expressed in delight at the stupidities of scientists as against the wisdom of the "simple man," a delight that at first seems appealingly democratic. But this is not the assertion that everyone is capable of rigorous and disciplined thinking. Instead, it denies the importance of serious complex thinking altogether in favor of the spontaneous smarts of uneducated certainties. They accept the dichotomy of knowledge versus values and opt for their particular values whenever there is conflict.

At the same time, conservative critics reject the fragmented and reductionist aspects of modern science on behalf of a holistic, "organic" view of the world. At an aesthetic and emotional level their holism partly resonates with that of radical criticism, but their holism is hierarchical

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and static, stressing harmony, balance, law and order, the ontological rightness of the way things are, were, or are imagined to have been.

The most consistent liberal critics of science accept the claims of science as valid goals but criticize the practices that violate them. They approve of science as public knowledge and deplore the secrecy imposed by military and commercial ownership of it. They want democratic access to science determined only by capacity, and they deplore the class, gender, and racial barriers to scientific training, employment, and credibility. They agree that ideas should be judged only on their merits and on the evidence, regardless of where the ideas come from, but they see hierarchies of credibility reinforced by a rich vocabulary for dismissing unorthodox ideas and their advocates as "far out," "quackish," "ideological," "not mainstream," "discredited," "anecdotal," or "unproven." They may be horrified by the uses of science in the production of harmful commodities or vicious weapons or the just as vicious justifications of oppression, without however relinquishing the belief that thinking and feeling should be kept separate.

Because of the increasingly obvious blindnesses, narrowness, dogmatism, intolerance, and vested interest in official science, alternative movements have sprung up, especially in health and agriculture. They must be examined with the same tools that we use to look at "official" science: who owns them, where do they come from, what viewpoints do they express, how are they validated, what theoretical biases do they manifest? Embedded as they are in a capitalist context, these alternatives too are a field for exploitation, produce commodities, and often are clothed in shameless commercial hype. They too have class roots that lead some of them to separate individual from social causation (for instance, criticizing the magic bullets of the pharmaceutical industry but peddling their own miraculous "natural" cures, or promoting holistic cancer treatments but ignoring the industrial origins of many cancers). The alternative communities are domains where insightful radical critique mixes with petty and medium-scale entrepreneurship.

Marxist critique attempts to see science in both its liberating and oppressing aspects, its powerful insights and its militant blindnesses, as a commoditized expression of liberal European capitalist masculinist interests and ideologies organized to cope with real natural and social phenomena. Its ideology is both a product of European liberalism and a self-generated contribution to that ideology, not a mere passive reflection of it.

Particular radical critiques of agriculture, medicine, genetics, economic development, and other areas of applied science point out both the external and internal aspects that limit science's ability to reach its stated goals. The external refers to its social position as a knowledge industry, owned and directed for purposes of profit and power as guided by shared

beliefs, carried out mostly by men. The modes of recruitment into and exclusion from science, the various subdivisions into disciplines, the hidden boundary conditions restraining its inquiry become intelligible when we examine its social context. We can approach the dominant modalities of chemical therapy in medicine and farming as expressions of the commoditization of knowledge by the chemical industry. But the reliance on molecular magic bullets is also congenial to the reductionist philosophy that has dominated European/North American science since its formation in the seventeenth century, and that in turn is supported by the atomistic experience of bourgeois social life. (As we trace the connections, we see that "internal" and "external" are in fact not rigidly alternative explanations, another example of the general principle that there are no nontrivial, complete, and disjunct subdivisions of reality. Yet science is still plagued by the false dichotomies of organism/environment, nature/nurture, deterministic/random, social/individual, psychological/physiological, hard/soft science, dependent/independent variables, and so on.)

The internal refers to the reductionist, fragmented, decontextualized, mechanistic (as against holistic or dialectical) ideologies and liberal-conservative politics of science. Marxist and other radical critics have always called for broadening the scope of investigations, placing them in historical context, recognizing the interconnectedness of phenomena, and the priority of processes over things, while conservative ideology usually advocates elegant precision about narrowly circumscribed objects and accepting boundary conditions without even acknowledging them.

(7) A radical critique of science extends also to the inner workings of the research process. In approaching a new problem, my Marxism encourages me to ask two basic questions: why are things the way they are instead of a little bit different, and why are things the way they are instead of very different? Here "things" has a double meaning, referring both to the objects of study and to the state of the science studying them.

The Newtonian answer to the first question is that things are the way they are because nothing much is happening to them.

But our answer is that things are the way they are because of the actions of opposing processes. This first question is that of the self-regulation of systems, of homeostasis. In the face of constantly displacing influences, how do things remain recognizably what they are? Once posed, it enters the domain of systems theory in the narrow sense, the mathematical modeling of complex systems. That discipline starts with a set of variables and their connections and applies equations to ask, is the system stable? How quickly does it restore itself after perturbation? How much does it respond to permanent changes in its surroundings? How much change can it tolerate? It asks, when external events impinge on the system, how do they percolate through the whole network, being amplified

along some pathways and diminished along others? We work with notions such as positive and negative feedback loops, pathways, connectivity, sinks, delays, reflecting and absorbing barriers. In its own terms, this analysis is "objective." But the variables themselves are social products. For instance, the apparently unproblematic notion of population density has at least four different definitions that lead to different formulas for measurement and different results when the measurements are compared across countries or classes. We could simply divide the total number of people by the total area (or resource):

$$D = \Sigma\text{people}/\Sigma\text{area}.$$

We could ask, what is the average density at which people live? Then we would use

$$D = \Sigma(\text{people/area})(\text{people in that area})/\Sigma\text{people};$$

the unevenness of access to resources or land is then included. Or we could do the same but from the perspective of the resource. The total resource per person is

$$D = \Sigma\text{area}/\Sigma\text{people},$$

the average intensity of exploitation of a resource is given by

$$D = \Sigma(\text{area/people})(\text{area})/\Sigma\text{area}.$$

Thus even what seems to be an objectively given measure is laden with viewpoint, and this is either taken into account or hidden. Nancy Kreiger (1994) has used the metaphor of fractal self-similarity to stress that the inseparability of the social and biological occurs at all levels, from the most macro to the fine details of the micro in epidemiology.

The second question is the question of evolution, history, and development. Its basic answer is, things are the way they are because they got that way, not because they have to be that way, or always were that way, or because it's the only way to be. From this perspective we reexamine the first question and ask, what variables belong in the system anyway, and how did they get there? What do we really want to find out about the system? What do you mean "we"? Who says? Do new connections appear and old ones decline? Do variables merge or subdivide? Do the equations themselves change? Should we use equations or other means of description? And since we know that the models we use are not photographically accurate pictures of reality, how would departures from the assumptions affect the outcomes? When does this matter?

What were the givens in the first formulation now become the questions. It is here that the powerful insights of Marxists dialectic, when combined with substantive knowledge of the objects of interest and the manipulative skills of the craft, have been most productive. Here the familiar propositions of the unity and interpenetration of opposites, universal connection, development through contradiction, integrative levels, and so on, so dry in the listings of the formal manuals, burst with rich implications and scintillate with creative potential.

Finally, these same methods are used reflexively to examine the historical constraints that have acted on Marxism itself as a consequence of its own historical circumstances and the composition of Marxist movements. But these methods should not be used in a mechanistic, essentialist way, rejecting notions because they are European and therefore foreign in Latin America, or male and therefore irrelevant to women, or of nineteenth-century origin and therefore inapplicable to the twenty-first. After all, every idea is foreign in most places where it is held, and in all places in the world most of the current ideas are of foreign origin. Rather, the historical context can be used to evaluate the ideas critically, to discover the insights and limitations and the needed transformations. The insights of feminism and the ecology movement, particularly those branches that have already overlapped with Marxism, are especially helpful in gaining the distance needed for this examination. Themes which had been relegated to the periphery of most Marxist vision can now be restored to their rightful places in historical materialism, and societies studied more richly as social/ecological modes of production and reproduction.

(8) Although different theories use different terms, look at different objects, and have different goals, they are not mutually unintelligible. Linnaeus saw species as fixed at the time of creation, with each particular example being a corrupted version of the archetypal design. Evolutionary biologists see species as populations that are intrinsically heterogeneous and subject to forces of change. The description of the typical is then seen as an abstraction from the array of real animals or plants. Nevertheless, I still use Linnaean Latin names for genus and species, many of which Linnaeus himself would recognize, and I could talk with Linnaeus about plants, argue about their anatomy or geographic distributions. He would be delighted to learn that our technologies have given us new ways of distinguishing among similar plants. We would disagree about the significance of variation within a species, and I don't know how he would react to the shocking idea that similarity often implies a common origin. But we could talk.

This is even true across larger cultural divides. All peoples name plants and animals. Most peoples assign different names to plants that correspond to different Linnaean species, and divide up the botanical

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world much as we do. They also tend to distinguish more finely among organisms that have to be dealt with differently. And like our own theories, theirs also "work." They guide actions that often enough lead to acceptable results. Whether you are a modern taxonomist who recognizes that half the snakes in Darien are poisonous or a Choco who will tell you that all snakes are poisonous but only kill you half the time, the practical conclusion is similar: when walking in the forest, beware of snakes.

Furthermore, the tools of investigation show a greater continuity than the theories. Galileo would be impressed by our more sophisticated telescopes but would not be completely lost in a modern observatory. While a Marxist economist might not be interested in the input-output equilibrium models of the neoclassical school or the techniques of cost-benefits analysis so dear to the corporate mind, these would be perfectly comprehensible to her. The claim that different outlooks are incommensurate, speak different languages, and find no points of contact is a gross distortion of the understanding of social viewpoint. Theoretical barriers do not mean the existential aloneness imagined by distant observers.

(9) The diversity of nature and society does not preclude scientific understanding. Every place is clearly different and every ecosystem has its unique features. Therefore, ecology does not look for universal rules such as "plant diversity is determined by herbivores" or attempt to predict the flora of a region by knowing its rainfall. What it can do is look for the patterns of difference, the processes that produce the uniqueness. Thus, the number of species on an island depends on the processes of colonization and speciation increasing numbers and the processes of extinction reducing numbers. We can go further and relate colonization to distance from a source of migrants, extinction to habitat diversity and area and community structure, try to explain why the migrants are of a particular type, and so on. The outcomes will be very different on tiny islands where populations do not last long enough to give new species or are so close to the source of migrants as to swamp any local differentiation, from islands that are very remote, with high habitat diversity.

Thus the use of site specificity to reject broad generalizations is misplaced. What we look for is the identification of the opposing processes that drive the dynamics of a kind of system (e.g., rain forest, or island, or capitalist economy) rather than propose a unique and universal outcome.

(10) Radical defenders of science cannot defend science as it is. Instead, we have to come forward as critics both of liberal science and of its reactionary enemies. The present right-wing attack on science is part of a more general assault on liberalism, now that the demise of a worldwide socialist challenge makes liberalism unnecessary and intensified competition during a period of long-term stagnation makes liberalism seem

too costly. Although its opposition to liberalism is opposition to the liberating aspects of that doctrine, the reactionary attack on liberalism often emphasizes the oppressive or ineffectual sides of liberalism.

We have to call for opening science up to those who have been excluded, democratizing what is a very authoritarian structure modeled on the corporation, and insist on the goal of a science aimed at the creation of a just society compatible with a rich and diverse nature. We should not hide behind but rather undermine the cult of expertise in favor of approaches that combine professional and nonprofessional participation. The optimal condition for science is with one foot in the university and one in the communities in struggle, so that we have both the richness and complexity of theory coming from the particular and the comparative view and generalizations that only some distance from the particular can provide. It also allows us to see the combination of cooperative and conflicting relations we have with our colleagues and ways in which political commitment challenges the shared common sense of professional communities.

We should not pretend or aspire to a bland neutrality but proclaim as our working hypothesis: all theories are wrong which promote, justify, or tolerate injustice.

We should not cover up or only lament in private the triviality of so much published research but denounce that triviality as coming from the commoditization of careers in scholarship and from the agendas of domination that rule out of order many of the really interesting questions.

We should challenge the competitive individualism of science in favor of a cooperative effort to solve the real problems.

We should reject the reductionist magic bullet strategy that serves commoditized science in favor of respect for the complexity, connectedness, dynamism, historicity, and contradictoriness of the world.

We should repudiate the aesthetics of technocratic control in favor of rejoicing in the spontaneity of the world, delighting in the incapacity of indexes to capture life, savoring the unexpected and anomalous, and seeking our success not in dominating what is really indominable but in farsighted, humane, and gentle responses to inevitable suprise.

The best defense of science under reactionary attack is to insist on a science for the people.

Reference

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