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## The Troubled Relationship of Science to Environmental Policy: Some New Perspectives

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## BOOK REVIEWS

### THE STATE OF THE NATURAL RESOURCES LITERATURE

**Helen Ingram\* & Bryan McDonald\*\* on The Troubled Relationship of Science to Environmental Policy: Some New Perspectives**

**Books Discussed:**

ROBERT J. BRULLE. *Agency, Democracy, and Nature: The U.S. Environmental Movement from a Critical Theory Perspective*. Cambridge, MA & London: MIT Press, 2000. Pp. 347. \$27.00 paper.

FRANK FISCHER. *Citizens, Experts, and the Environment: The Politics of Local Knowledge*. Durham, NC: Duke University Press, 2000. Pp. 352. \$19.95 paper.

JAMES FLYNN, PAUL SOVIC, & HOWARD KUNREUTHER, eds., *Risk Media and Stigma: Understanding Challenges to Modern Science and Technology*. London & Sterling, VA: Earthscan, 2001. Pp. 399. \$39.95 paper.

MARY O'BRIEN. *Making Better Environmental Decisions: An Alternative to Risk Management*. Cambridge, MA & London: MIT Press, 2000. Pp. 286. \$22.95 paper.

The relationship of science to environmental policy is increasingly contested. Science has never before been so closely linked to both the discovery of and solution to environmental problems such as global climate change, the extinction of species, deforestation, decline in biodiversity, the spread of environmentally related human diseases, and the management of natural resources. Yet popular and scholarly criticism of the role of science in environmental policy has risen alarmingly in recent decades. The objectivity of science is questioned as increasingly it is funded by businesses that profit from scientific development of new technologies, the safety of which is controversial. Further, scientists are

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accused of being elitists who use specialized language that is opaque and uninformative to ordinary citizens concerned about risk and safety.

The four books under review here reflect upon these and other arguments about the impartiality and democracy of science as it relates to environment and risk. While each is critical of environmental science as currently practiced, the authors come from different disciplinary and philosophical perspectives and their recommendations as to how the role of science in environmental policy can be improved are noticeably dissimilar.

The close relationship between science and public policy in the United States dates back at least to the Progressive Era of the early twentieth century when Theodore Roosevelt was President of the United States and Gifford Pinchot was Chief Forester of the redefined U.S. Forest Service. Their approach to the management of resources was to support "wise use," to be determined by rational, specialized analysis. Safeguarding and scientifically managing land, water, and wildlife were seen as means to meet the needs of a democratic society. The democratic wish of the progressives was to replace the clash of special interests haggling over exploitation of natural resources with the objective decisions of professionals with scientific training. Later, the critical role played by scientists in winning World War II convinced many that more great accomplishments could come out of a partnership between science and government. By extrapolation, entrenched problems such as poverty and the dislocating effects of economic cycles were believed to be amenable to scientifically based solutions. An implicit pact emerged between science and government in the early 1950s such that scientists could expect major funding by government and employment of their graduate students in government jobs in exchange for research addressing national needs.

The bond between science and government in the environmental field was reinforced in the 1960s by the rapid development of space programs and in the 1970s when the public first became aware of and alarmed by the poisonous effects on living things, including humans, of a large number of new chemicals being released into the environment. While it was clear that science itself generated the creation of many of the new pesticides and food additives that were turning out to be dangerous, many governmental leaders and others continued to believe that scientific assessment of potential harms and identification of possible remedies was the best course of action. Scientific research became part of the toolkit of both environmental groups and governmental agencies charged with environmental protection. Since science knew the most about the properties of new chemicals, it was also skilled at addressing whether or not new chemical substances constituted a significant threat.

Quantitative risk assessment became the scientifically based tool of choice to evaluate issues of risk and safety.

Quantitative risk assessment has evolved into a large-scale scientific enterprise with graduate programs emerging in a number of universities, specialists with risk assessment training hired into government and private enterprise, and the emergence of risk assessment associations and journals. The scientific identification and evaluation of risk is intended to make policy choices about risk management more rational. That is, risks that are both more certain and more serious are to be distinguished and given higher priority attention than less likely and less serious threats.

The editors and authors of *Risk, Media and Stigma* recognize that public attitudes toward risk are often not rational, at least in the terms that risk assessment endorses. Instead, the stigmatizing of technologies, places, and products amplifies risk into something unduly dangerous. In the reprinted introductory chapter, Robin Gregory, James Flynn, and Paul Slovic explain that stigma goes beyond normal conceptions of a hazard rationally compensatable with money and relates to something that should be shunned. Stigma implies something that is blemished or tainted beyond reasonable redemption. Risks with certain kinds of consequences are especially susceptible to stigmatization. Results that are inequitably distributed, unbounded, and unnatural, affect innocents like women and children, or result from improper management or actions are most likely to generate stigma. Extensive media coverage is both the cause and consequence of stigmatization. Further, stigmatized technologies, places, and products arouse staunch, persistent, and often unbeatable opposition.

The creation of stigma is a social rather than a scientific process, and stigma would seem to be impervious to scientific challenges. In the second chapter, by Roger Kasperon, Nayna Jhaveri, and Jeanne Kasperon, a model of the social amplification of risk is presented including an initiating event, channels of communication, social institutions and organizations, and signals to society. "Risk ripples" amplify the extent of impact and involve secondary or tertiary impacts far beyond the people directly affected. A stigmatized technology, place, or product is marked or labeled in a highly negative fashion, and this mark affects identity so that victims see themselves as tainted. This affects how they behave and how others behave towards them.

In the sections that follow, authors address different case histories of real world stigma including contamination, nuclear energy, and stigmatized places, products, and industries. Contagion, as it relates to stigma is far removed from the exposure/dose/response calculation underlying quantitative risk assessment, and evokes disgust and moral outrage that are unamenable to quantification. The contagion related to

mad cow disease (BSE) is especially telling in that it displays all the features relevant to enhancing fear. Cows were fed unnatural and disgusting foods and became infected with an invidious microscopic disease that attacks the mind of both the cattle and human consumers of beef, often after a long latency. The spread of contagion through the mouth contributes to the aversion. The BSE case illustrates a particular feature of stigma, that is, the loss of trust. The British public and other European consumers reacted strongly and emotionally, at least in part in reaction to the longstanding "official" reassurances that no danger existed. The loss of trust in authority and expertise is especially notable in coming to an understanding of how science has been undermined in terms of authoritative interpretations of risk.

While *Risk, Media and Stigma* contributes importantly to an understanding of the social, psychological, and political processes related to amplification of risk perception beyond what can be scientifically justified, most authors implicitly disapprove of the irrationality of stigma. Their work is intended to inform scientific risk assessments so that stigmatization may be anticipated and perhaps avoided. Stigma, to some extent, is viewed as a risk management failure, that is, failure to understand the political and social context in which the public is perceiving risk, and to engage in the appropriate risk communication strategies. In their chapter on coping with stigma, Howard Kunreuther and Paul Slovic suggest several strategies for dealing with stigma, among which are reducing perceived risks and their social amplification. Among their instructions are the education and desensitizing of the public and informing scientists about the ways in which risk assessments may unwittingly breed fear. The final two chapters of the book take issue with the predominant perspective of other authors to the edited volume that stigma is a threat to more reasonable scientifically based quantitative risk assessment. Vern Walker notes the difficulty of knowing the difference between real risk as accurately perceived and stigma. Baruch Fischhoff notes that stigma often reflects a moral statement of what constitutes acceptable behavior, and when this is the case, attempts to change or adjust perceptions and behaviors related to stigma assume a moral superiority on the part of those applying strategies to cope with stigma. This, he notes, may not be a comfortable or appropriate role for scientists intending to be objective.

Mary O'Brien, author of *Making Better Environmental Decisions: An Alternative to Risk Management*, goes much further in branding quantitative risk management as inherently biased and in doing so expresses a strong bias of her own. As with the edited volume reviewed above, the intended audience for O'Brien's book is those involved in risk assessment. However, O'Brien is also aiming to inform a more general public that she would like to mobilize to support a fundamental shift

toward the adoption of an alternative to quantitative risk assessment. While the other books in this essay are heavy on theory and references, *Making Better Environmental Decisions* is replete with statements of principles such as, "It is unacceptable to harm humans (or nonhumans) when there are reasonable alternatives" (p.11), and "We have no choice but to change our environmentally bad habits everywhere." (p.13). It would be inaccurate to suggest that Mary O'Brien is engaged in moral philosophy rather than science, however. Much of the book is devoted to a simplified but often cogent critique of the limitations of quantitative risk assessment.

The author argues that while scientific studies and science can help to understand some of the risks and damages caused by particular substances and activities, science cannot tell how much of a dangerous substance or activity is safe for humans or the more general ecosystem. Risk assessors cannot account for all the toxic substances already contaminating and affecting people and species in the real world. Nor can they account for individual sensitivities to substances. There are often adverse effects of a hazardous substance or activity of which quantitative risk assessments are unaware and therefore fail to calculate. Moreover, natural systems are so complex and interrelated that it is extremely difficult to predict multiple, interdependent effects of cumulative stressors. O'Brien is especially concerned about effects that are only beginning to be revealed concerning exposure to toxins on immune and reproductive systems. Further, she warns of alarming new evidence about effects in the offspring of those exposed to substances, effects that may not evidence themselves directly to those exposed to toxins and other hazardous substances.

Despite the mounting evidence about the inadequacies of quantitative risk assessment, the tool continues to be used because of the strong interests that support and profit from it. Risk assessments serve private business interests, she argues, because they are biased in favor of minimizing risks and provide business with regulatory certainty. Bureaucracies like quantitative risk assessment because it provides legitimate rationales for regulatory decisions and routinizes what would otherwise be difficult decisions. While scientists know the limitations of risk assessment, they believe that the information informs decisions that would otherwise be made on purely political grounds, and even though many of the involved scientists' objectivity is compromised because of funding from or employment by government and industry. O'Brien notes that risk assessments contain so many assumptions that they can be manipulated endlessly to achieve politically preferable results. Moreover, risk assessment models are so complex that they are intimidating to citizens and give the upper hand to agencies and businesses.

While O'Brien's book provides a logical and reasonable basis for the strong emotional reaction the public sometimes has to risk about which the authors in *Risk, Media and Stigma* write, ultimately the critical reader must remain skeptical. While the author complains about the lack of objectivity of quantitative risk assessment, her own analysis is driven so strongly by an agenda that the charge rings somewhat hollow. The book endorses something broadly classified as alternatives assessment, which is envisioned as a process of considering a range of reasonable alternatives and their potential environmental, public health, and social benefits and effects. Among the examples of successful application of such assessments are the National Environmental Policy Act, the Endangered Species Act, the Montreal Protocol, and the Massachusetts Toxic Use Reduction Act. What O'Brien suggests is a change in policy, process, and decision rules for evaluating risk. O'Brien wants regulation of toxic and hazardous substances to serve different, much more environmentally protective goals. Changing or improving the problematic role in which science finds itself in relation to the environment is not really a major concern for this author. Science in relation to the environment is likely to continue to be fiercely contested even if alternative assessments were widely adopted, except criticisms would come from different quarters including from most risk assessment scientists.

In *Citizens, Experts, and the Environment: The Politics of Local Knowledge*, Frank Fischer engages in a more fundamental and more scholarly critique of the role of science in environmental policy. As a critical political theorist, Fischer relies heavily on critical European and other internationally based scholars, including among others Ulrich Beck, Brian Wynne, Anthony Giddens, Jurgen Habermas, Bruno Latour, and John Dryzek, to reconstruct the concepts of risk, reason, the scientific process, and democracy. The central argument of the book is that in the modern risk society, risks are beyond any management regime and therefore decisions about risk must be made in open, public forums in which scientists have no larger voices than other citizens. In such a context, experts come to be understood as no more than a "specialized" citizen in policy-making processes.

The book is divided into four parts, each of which builds upon and amplifies arguments introduced earlier. The advantage of this organization is that the reader is introduced to some rather dense and difficult philosophical arguments without being put-off as is sometimes the case with critical theories. The downside is that the book can seem repetitive, especially for the reader well acquainted with Fischer's other works including *Technocracy and the Politics of Expertise*.

How scientists came to dominate decisions concerning environmental risk is the subject of Part I. The argument rests on two

important concepts, the first of which is the risk society. Fischer relies here on the insights of the German Sociologist Ulrich Beck to argue that governments today face a crisis of legitimacy because while their job is to insure public welfare and safety and at the same time to promote technological advance and material progress, the risks associated with modern life have gotten out of hand. A fundamental shift in industrial society has occurred so that the positive production of goods and wealth has come to be overshadowed by the attendant visible and worrisome distribution of risk. In this dangerous new world, the state and science working in tandem are forced into the increasingly untenable positions of assuring the public of its safety. Contemporary risks cannot simply be displaced upon the poor and working classes as was once the case with ordinary industrial risk. Instead, risks from such modern threats as global warming, nuclear accidents, and biotechnology gone awry, are felt by all social groups at the same time. Moreover, these risks are unmanageable, as evidenced by the fact that they are largely uninsurable. When insurance has to deal with the possibility of destruction across the planet, the calculus of casualty, compensation, and liability becomes impossible and meaningless. Thus, Fischer argues, we face a paradox. At a time when hazards and catastrophes appear to be the most nefarious, they slip through the net of attempts by science and other institutions to capture and remedy them. It is clear that the combined efforts of environmental bureaucracies and environmental scientists are simply not adequate. In fact, science itself is the generator of much of the danger. Whereas science typically seeks reliable knowledge through experiments, in the case of today's dangerous technologies, the process is reversed. Before scientists can learn about the dimensions of such disasters as nuclear melt down or breaches in biosafety, nuclear reactors must be built, and artificial biotechnical organisms must be released into the environment. Scientists are in no position to insure the safety of products or actions until experiments have taken place and scientists have transformed society itself into its laboratory.

The second core concept in *Citizens, Experts and the Environment* is the postpositivist understanding of knowledge. The argument is advanced by the insight that all perceptions of the world around us are filtered through the minds of the perceivers with all their biases, blind spots, and other limitations. Science with its processes of hypothesis testing, sophisticated instruments, precise measurement, verification, and peer review is the best institution humans have to correct for human limitations. Science is nonetheless a social process in which it is impossible to separate out meanings and values. Postpositive approaches to knowledge accept that science offers an account of reality rather than reality itself. That is not to say there are no real and separate objects of



inquiry independent of the investigators but instead to recognize that the vocabularies and concepts used in the effort to know are socially constructed (p.75). While it might appear that acknowledging that "facts" are constructed by scientists through networked social processes would open science up to even more criticism from an already overwrought public in the risk-society, Fischer argues just the opposite. One of the principle sources of error and the deterioration of public trust in science, he maintains, is its overly narrow, disciplinary-based, fragmented, reductionist studies of environmental risk. The pathway toward greater acceptance of science in environmental policy making is to open it up to many physical and social science disciplines bringing into play a multi-methodological range of intellectual skills both quantitative and qualitative.

Frank Fischer echoes other critical theorists in noting the extent to which instrumental or technical rationality dominates environmental decision making. He notes that the many environmental laws adopted since 1970 have a distinctively technical orientation and they thrust upon government agencies the burden of scientifically defining acceptable levels of pollution, pollution abatement, and risk exposure to environmental pollutants. As a consequence, governmental agencies have evolved complex mechanisms for the involvement of science in official decisions. The government/science partnership, he argues, has tended to exclude the participation of ordinary people through the use of technical terminology, models, and the other trappings of expertise. Technicians have employed the utilitarian calculus that empirically measured consequences rather than social preferences to provide the appropriate standards for policy making. The science related to the environment is highly complex, uncertain, and subject to varying interpretations. The outcome is a politics of counter-expertise where various interests try to support policy alternatives advantageous to themselves through testimony of scientists and experts in their employ. The politics of counter-expertise results in a cacophony of conflicting voices that provide poor policy guidance and undermine the credibility of science with the public.

Science controversies in the environmental field have spawned a search for alternatives to the conflict ridden politics of counter expertise. Science courts, environmental mediation, and alternative dispute resolution have been explored with no great success, at least in part because these tools continue to bias the deliberative process in technical rather than democratic directions. The heart of Part II develops an alternative to technical reasoning that Fischer terms cultural reasoning. Fischer argues that there is often a sound basis for the public reaction to environmental threats that are branded and dismissed as stigmatization in the Flynn, Slovic, and Kunreuther volume. Cultural rationality is

geared to giving equal weight to personal and familiar experiences rather than depersonalized technical calculations. Focusing on the opinions of traditional social and peer groups, cultural rationality takes into account issues of trust, responsiveness, and accountability. It makes sense from a culturally rational point of view to ask about the institutional and social affiliation of experts, their reputation for openness and candor and the extent to which they can be trusted. Procedure becomes as or more important in discourse about cultural rationality as substance.

Cultural rationality can take its rightful place in environmental decision making and the current controversies over the role of science in society can be dampened only if the kind of science conducted on environmental issues is changed substantially. Part III of *Citizens, Experts, and the Environment* concentrates on methods for and examples of incorporating local knowledge and participatory inquiry into environmental science. Fischer admits that attempts to meaningfully involve citizens in research have more often failed than succeeded, and token involvement is worse than no participation at all. The number of successes from which Fischer draws lessons is small, and he relies heavily on experience in Woburn, Massachusetts; Kerala, India; and the Highland Center in Tennessee. Popular epidemiology and resource mapping are among the methods discussed and endorsed. Fischer cites clear evidence that citizens can, if they want, make important contributions and lend significant insights to the resolution of environmental problems. He is less convincing in explaining whether or why such participation can become the norm rather than the exception.

The final part of the book addresses how participatory inquiry might become institutionalized in social and political life. Attention is paid to the concept of civic discovery, so much discussed in contemporary management and public administration literature. Although Fischer endorses opening up forums for communication, he finds civic discovery wanting for lack of clear mechanisms to bring the public into discussions. The Danish "consensus conference" is offered as a better model. It is a citizen tribunal aiming to inform parliament and stimulate public discussion of important issues. Participants are chosen for their interest and representativeness; the group studies a topic for several months aided by communications facilitators and experts. The conferences have been effective and influential and have gotten their recommendations against animal gene technology, food irradiation, and for a tax on automobiles have been accepted by the parliament, which respects the conferences' findings.

In order for participatory institutions to make headway, Frank Fischer suggests that a new field or specialization be adopted that he labels "policy epistemics." The field would focus on the ways people communicate across differences, the flow and transformation of ideas

across borders of different fields, how different groups, including experts, and local communities, see issues differently, and the ways in which these differences become the basis for disputes. Such a field would address many of the difficult issues raised by Fischer including how to bridge empirical and normative knowledge and how to include local as well as abstract forms of knowledge. Uncovering the epistemic dynamics of public controversies would be the task of this new field and would allow for an enlightened understanding of what is at stake in disputes and for more sophisticated evaluation.

The way in which Frank Fischer explains and integrates numbers of different theories and concepts related to critical approaches to science is commendable. Whether or not readers are sympathetic to postpositivist perspectives, they are rewarded by learning a great deal about the subject through clear, well-written prose. The criticism of elitist science engaged in utilitarian logic is very powerful. However, as is so often the case with critical theory, the solutions recommended are far less satisfying than the indictments of present practices. How any alternative might gain sufficient political power to change the present system is not satisfactorily explained. Further, the reader is discouraged at the very few success stories the author is able to cite.

In his book, *Agency, Democracy, and Nature: The U.S. Environmental Movement from a Critical Theory Perspective*, Robert Brulle finds the roots of contemporary environmental degradation not so much in the troubled relationship between science and society than in the failure of social institutions. While Brulle shares much the same criticism of the scientism that dominates contemporary environmental discourse, he finds change in the environmental movement to be the most fruitful pathway toward improvement. Like Fischer, Robert Brulle is a self-conscious academic whose writing is well supported by a rich bibliography. The author takes his credentials as a sociologist very seriously, and the non-sociologist reader may be somewhat put off by the self-conscious attempt to link the present work to that of the great figures in sociology like Weber and Parsons. At the same time, Robert Brulle's grounding in sociology leads to very insightful treatment of environmentalism as a social movement containing a number of often conflicting discourses. Among the nine different discourses existing within environmentalism today, Brulle notes the prominence of natural and health sciences in the conservation, wildlife management, and the reform environmentalism discourses. As a consequence, there is an over reliance on instrumental rationales as opposed to the more values-based discourses such as ecofeminism, deep ecology, and environmental justice. The science dependent frames, Brulle argues, tend to distort the discourse excluding some aspects of the world and limiting the choice of alternatives. Excessive reliance on technology avoids the political

discussion that really needs to take place. The formal discourse of predominant strands of the environmental movement distances it through its reliance on technical language and posed neutrality from the kind of grass roots mobilization that might lead to significant social learning.

The most original and most useful part of *Agency, Democracy, and Nature* is the research on the contemporary environmental movement. The major contribution of the volume is a framework for evaluating the environmental movement and new knowledge about environmental groups including their membership, economic assets, organizational practices, and the discursive frames with which they are associated. In the mid 1990s, environmental groups had a total membership of around 41 million. The total number of U.S. environmental organizations is estimated to be about 10,000, which combined have around 28,000 staff employees with an annual income of around 2.6 billion dollars and assets of 5.8 billion. These figures make the environmental movement one of the largest movements in U.S. history and bigger than other movements such as the civil rights or the peace movements. Compared to other nonprofit organizations, the environmental movement has significant presence in the policy-making process. However, the level of financial contributions places the environmental movement at a very low level in comparisons with religious or industrial organizations.

Robert Brulle also provides extraordinarily useful information about the non-quantitative aspects of the environmental movement. He explores the history of the emergence of the various discourses within the environmental movement, reaching much further back than Earthday 1970, which is often regarded as the beginning of the modern environmental movement. Brulle shows that the historical baggage of the wildlife management and conservation movements continue to affect the framing of issues today. As he traces the various strands of the environmental movement separated by their distinctive style of discourse, he assesses what each has to offer in terms of social learning. He finds that the hierarchical structure of many groups in addition to the excessive dependence of many organizations upon foundation funding limits learning capacity. In particular, the lack of democracy and responsiveness and excessive bureaucratization has blighted democratic and social learning possibilities. Without question, *Agency, Democracy, and Nature* is the best book available on the environmental movement published in recent years. It is comprehensive, accurate, and theoretically informed by the most recent theory of social movements.

Robert Brulle places his hopes on the emergence of a metanarrative, like biodiversity, that might bridge the very different narratives and discourses that characterize the present day environmental movement. Such a metanarrative does not imply some

sort of forced consensus, but instead recognition and inclusion of multiplicity and particularity. Another critical condition for a rejuvenation of the environmental movement is a change in the excessive control that foundations currently exercise over environmental groups. While providing only about one-quarter of environmental groups' budgets, foundation grants nonetheless exercise undue control over the agendas and strategies of groups. They limit the growth of a "green public sphere" where an open dialogue could take place without some heavily funded voices drowning out others. Finally, Brulle argues for the development of much more democratic structures within environmental groups where membership plays a greater policy role. Like many other critics, Brulle strongly faults the slick, commercial-style mass mailing fund solicitations that lead to excessive turnover of membership among those only loosely tied to the organization and who contribute only in terms of sending in money.

The theme of *Agency, Democracy, and Nature*—the need to reform social institutions in general and the environmental movement in particular—shifts the focus of contemporary malaise over environmental policy away from science. In light of the experience of the last few decades, and criticism such as provided in the four books reviewed here, heavy dependence upon scientific advances to resolve environmental problems appears unwise. The Progressive Era reliance on science to replace politics and the post-World War II pact between science and government to solve problems with science and technology in exchange for government funding turn out to be misguided thinking that belongs in the dust bin of history. The solution to contemporary environmental problems lies not in changing science by changing the rules of evidence, including lay people in all phases of research, or elevating the status of ordinary knowledge. It is not so much that science needs democratization, but that democracy itself needs to be made to work better. The heart of the problem is the lack of adequate institutions and processes through which to instigate and sustain a productive dialogue over conflicting environmental and developmental values. Instead of relying on well functioning political and legal processes, scientists are expected to provide effective, efficient, and politically feasible answers to difficult dilemmas. The answer to such problems probably lies less in creating some kind of civic or participatory science than in constructing a more robust democracy. Elected politicians should not be able to escape their responsibilities to facilitate value discussions and ultimately make difficult value choices by simply using the standard of "best available science" to justify decisions made. Scientists should not be used as the fall guys for bad decisions and then blamed for their overweening power. Instead, what is necessary is much more democratic politics. Among the books reviewed here, *Agency, Democracy and Nature* by

Robert Brulle does the best job in scouting out fruitful directions for political and institutional change.

## REVIEWS

*Desert Ecology. An Introduction to Life in the Arid Southwest.* By John Sowell. Salt Lake City: University of Utah Press, 2001. Pp. 192. \$17.95 paper.

This small book, 6" X 9" and 192 pages, is organized into nine chapters. An opening chapter describes the general features of deserts, two chapters treat plants (adaptations to arid conditions, life histories), three cover animals (thermoregulation, osmoregulation, life histories), one discusses desert ecosystems (food webs, productivity), one describes desert mountains (the "sky islands" of the Southwest), and one chapter discusses humans living in desert environments.

This is a book worth reading if you are a novice to deserts and their ecology. It is largely well written, with a reasonable dose of "desert lore," some appropriate quotes, and good opening passages for each chapter. However, it treats the broad subject of deserts somewhat unevenly, and the writing could have benefited by some careful editing.

The opening chapter, with which most authors would hope to "hook" their readers, is rather unpolished. It starts strong, with a vivid description of Death Valley. But then, little-by-little, the writing becomes rather cumbersome. The information is generally there, it just isn't always precise or easily extracted due to the uneven writing. Terms are used without definition (e.g., *playa*, *arroyo*), allusions are attempted that don't always work (e.g., "oceanic deserts"), and examples are sometimes confusing (e.g., the coastal chaparral of Baja California seems to be treated as a desert, even though the map of southwestern deserts clearly excludes it, as well it should be).

The plant and animal chapters are probably the strongest, though showing a clear bias toward physiology over ecology and evolutionary biology. The coverage of plant physiology is excellent, and the discussion of CAM C-4 photosynthesis (a difficult topic about which to write) is one of the clearest I've read. However, the discussion of halophytes is so superficial as to be of little use. The chapter on plant life histories is generally well done, although it is, again, rather uneven. Sometimes Latin names of plants are parenthetically provided, other times not; readers unfamiliar with names like "saguaro" and "cardon" may not recognize these as cacti. Given the unevenness of the text, a glossary would have made this book far more useful. It could also have benefited by inclusion of a table listing common and scientific names of