ed by the Department of Defense to the National Institutes of Health. They also urge efforts to instill a greater sense of social responsibility in molecular biologists and encouragement of public interest lawsuits to challenge governmental activities in the biological warfare sphere. Piller and Yamamoto have their doubts about official reassurances regarding biological weapons and give considerable evidence to support their skepticism, especially pertaining to the Reagan years. They believe that restoring confidence in existing legal regimes of prohibition and taking steps to close loopholes provide our best hope of preventing the genie from escaping. Unlike Douglass and Livingstone, Piller and Yamamoto do not believe that biotechnology is advanced enough to pose immediate problems of military application (although they predict such a capability early in the next century), and they put the main burden of restoring confidence on Washington, not Moscow. Their reasoning and mastery of the subject matter make *Gene Wars* the best book now available on the subject. Its only weakness is a failure to develop a coherent, sustained framework of analysis, to present a fuller assessment of the Soviet record in chemical and biological weaponry, and to consider the activities of countries other than the United States and the Soviet Union. There is evidence, for instance, of biological weapons research activities in 10 to 12 countries. Will these programs pose serious threats, and if so, what should be done?

Gene Wars refers briefly to the open-air testing of certain biological agents secretly done the U.S. Army in the 1950s and '60s. *Clouds of Secrecy* is devoted entirely to that enterprise, drawing out its disturbing implications.

The full extent of these test programs has not yet been disclosed, but information revealed under the Freedom of Information Act and in connection with a lawsuit by a relative of someone allegedly killed by the testing does tell a compelling story, even if it is incomplete. Available information establishes that during the 1950s the Army Corps of Engineers, in conjunction with scientists at Stanford University and at a California corporation, conducted tests aimed at assessing the vulnerability of America to biological attack in the urban environments of Minneapolis, St. Louis, and San Francisco, as well as the New York City subway system. Some of these tests evidently used aerosols containing zinc cadium sulfide, "a fluorescent powder intended to approximate bacterial agents used in biological warfare" (Cole, p. 60). In other tests, actual bacteria were used, but not of a kind thought at the time to be harmful to the general population. Cole criticizes these tests because no efforts were made to monitor health effects on those exposed or to avoid exposure of vulnerable sectors of the population (the young, the old, the sick).

Apparently, millions of American citizens were exposed to these tests without being informed, and Cole shows that some individuals were probably harmed as a result and that the government continues to claim prerogatives to undertake such tests. Recent disclosures of decades of suppression of exposure of millions of Americans to radiation in the vicinity of nuclear weapons facilities suggest that our government in invoking national security is not to be trusted in relation to health hazards inflicted on its own citizens. Many people have complained about "covert operations" against overseas targets, but Cole's careful narrative illustrates a covert operation carried out at home against individuals who were selected at random and were completely "innocent."

Cole's book addresses a serious structural problem of constitutional democracy. He is less convincing concerning the degree of danger posed by the specific tests undertaken, and he does not establish whether in the setting of the early Cold War those who conducted the tests had reasonable grounds for believing some sort of clear and present danger of a Soviet attack plan with bacterial weaponry existed. It is also not clear that the biological agents used were at the time known to put those exposed at serious risk. Such clarification would help us decide whether the government acted in ignorance or in disregard of the risks involved. Nevertheless, Cole's exposé illustrates reliance on an unconditional version of the national security rationale—for the sake of military preparedness, citizens were treated as experimental subjects without opportunity to object or consent, and government officials acted without having been delegated authority to do so. If nothing else, *Clouds of Secrecy* suggests one more setting in which democracy and secrecy cannot be reconciled. It is obvious from a reading of *Clouds of Secrecy* that the public should demand more protection and Congress should mandate it.

These books taken together are disturbing, but for quite distinct reasons. *America the Vulnerable* is an irresponsible provocation, promoting a view that, to the extent it is persuasive or indicative of a mindset of government officials concerned with these issues, weakens prospects to stave off a biological arms race. In contrast, both other books make significant contributions by pointing up serious problems that need to be addressed. *Gene Wars* gives us an overview of why we need to take biological warfare seriously and what can be done, especially here at home, to reduce the risks. *Clouds of Secrecy* reinforces a central thesis of *Gene Wars* by its powerful demonstration that citizens cannot rely upon the forebearance of government in these matters and must find ways to oversee government activities. A beginning toward improvement in this regard would be a determined assault on the largely unexamined claim of necessity for official secrecy. A further step would be to impose stiff punishments upon those in government who covertly, knowingly, or incompetently expose citizens to health hazards. An additional step might be the designation of a trained corps of investigators mandated to protect the rights of the public against governmental abuse.

We are at a time when biological warfare may still be avoided, but only if determined action is taken here, in other countries, and on an international level. The scientific community obviously has a particular calling—to assess carefully the dangers from biotechnology, neither overstating nor understating the prospects, and on this foundation to find principles and procedures that permit social and medical gains from expected scientific advances without creating conditions likely to produce a biological arms race. These books under review, for what they do and do not say, help us fashion appropriate responses.

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Life in Danger

Biodiversity. E. O. WILSON, editor. FRANCES M. PETER, associate editor. National Academy Press, Washington, DC, 1988. xiv, 521 pp., illus. $32.50; paper, $19.50. Based on a forum, Washington, DC, Sept. 1986.

An unusual set of circumstances enabled me to read this book in an appropriate setting—Barro Colorado Island and the nearby Panamanian village of Gamboa. Here I was able to experience rich biological diversity at first hand, and also, within only a few kilometers, some of the factors that lead to its irretrievable loss. Though we all can experience biological diversity near our homes, the tropics are special, for here both diversity and threats to its continuance are overwhelming.

People are coming to understand that there is a crisis in respect to the diversity of life on Earth. Knowledgeable field biologists agree that we are about to witness a mass extinction that may rival those evidenced in the paleontological record, and a

sense of urgency pervades the worldwide community of scientific naturalists. This book is a manifestation of their concern.

The volume, which is attractively produced with a beautiful cover and good binding, records the presentations at the first National Forum on BioDiversity, sponsored by the National Academy of Sciences and the Smithsonian Institution. Many of the 61 contributors are well known for their work in conservation biology, and especially tropical biology—E. O. Wilson, Peter Raven, Daniel Janzen, David Ehrenfeld, Norman Myers, Paul Ehrlich, Russell Mittermeier, Thomas Lovejoy, Michael Soule, and more. The authors range from systematists and ecologists to economists, from pragmatic agriculturalists to theologians, and from conservation technologists to philosophers.

For the most part these are not original presentations. Many of the authors have written extensively on this topic, and the papers here are mostly reviews, restatements, or updated evaluations. But I can think of no better way to become familiar with the full spectrum of issues in the preservation of biological diversity than to read this book. It is an excellent point of departure, for it is loaded with information and all the chapters have helpful, up-to-date lists of references.

In addition to a thoughtful, stimulating introduction by Wilson and a brief epilogue in which David Challinor assesses the immediate impact of the forum, the book has 12 parts containing four to six chapters each, including brief introductions. These parts range in content from assessments of the present state and value of biological diversity and threats to it, outlines of strategies for preservation and restoration, and considerations of global, national, and local policy issues to statements of appreciation of the diversity of life by a poet, a writer, a theologian, and even James Lovelock of "Gaia" fame. There are a few turgid chapters, but since all are short these do not interfere with the general flow of the book.

I found only one definition of biological diversity, a quote from Bruce Wilcox: "the variety of life forms, the ecological roles they perform, and the genetic diversity they contain." This definition serves all of the chapters in this book.

There is great emphasis on the worldwide tropics, for if there is a battleground it is there. Not only is biological diversity greater in the tropics than in other latitudes, tropical habitats are undergoing profound changes, including threats of extinction, that many biologists fear may be irreversible. In these chapters you will find many true horror stories of the rate of conversion of tropical forests, the rate of loss of species (there seems to be some agreement that it must now be about one species per day), and the social, economic, and political barriers that prevent anyone from doing much about the problem as a whole. But there are some effective efforts being made by individuals, groups, organizations, and even nations, and these, too, are documented.

There exist many misconceptions concerning biological diversity. For example, though there is justifiable pride among those who have worked to establish nature preserves and national parks, reserves will not solve the problems of biodiversity, as many authors recognize. Wilson points out that even if endangered species can be saved from extinction, such species almost certainly will have lost most of their internal diversity and have become almost genetically uniform in the process. The establishment of a reserve is often a signal to destroy everything surrounding it, until the edges of the reserve itself undergo cultural erosion and the reserve declines.

The popular media have featured endangered megafauna—whales, pandas, condors, rhinos, and the like. But there is little understanding among the public of the extent to which insects, plants, and other groups will be affected by the mass extinction that is now beginning. We have only a rough idea of how many species of insects exist, and vast numbers remain undescribed. Many will disappear without ever having been noticed by humans. Tropical forests are so rich that even some large trees, dominating local forests, have remained undescribed until recently. The coming extinction will affect plants far more than have the mass extinctions of the past.

Many chapters point out the array of values biological diversity holds for human enterprises, but Ehrenfeld has a different view: biological diversity is of intrinsic value, and the public must come to understand the inherent wrongness of its destruction. This is a lofty and inspiring view; and for those who want pragmatic examples of the value of biological diversity, the other chapters are richly supplied with them.

Because the tropics are being affected so severely, we tend to think of the loss of biological diversity as a problem of the Third World. But many examples from the so-called developed world can be found—acid rain is only one of the more recent factors. Peter Vitousek points out that nearly half of Hawaii's largest native-dominated lowland rain forest was cleared during 1984 and 1985 in a subsidized endeavor to generate electricity from wood chips.

Perhaps there are some bright spots in an otherwise gloomy picture. There is still time to accomplish much if the developed countries of the world recognize their responsibility (as Michael Hanemann observes, "If we want developing countries to protect their biological resources we should be willing to pay them to do so"). Restoration ecology is becoming increasingly sophisticated and successful. Marine organisms are being far less affected by current changes than are terrestrial plants and animals. If a substitute for simple firewood could be found and distributed, the impact on tropical forests would be profound.

But a crisis is at hand. The best-informed conservationists and naturalists in the world are deeply alarmed and are sounding a warning to us all. To Wilson the magnitude and control of biological diversity is one of the key problems of science as a whole, and we are about to lose our opportunity to study it. There is much agreement that the growth of the human population is the fundamental cause of the loss of biological diversity. Ehrlich points out that Earth's habitats are being nickeled-and-dimed to death, and we have difficulty perceiving and reacting to changes that occur on a scale of decades. Politicians get away with platitudes because there is no general awareness of the magnitude of the problem.

Biodiversity may become the rallying call for the next decade. It is a concept that is coming to be understood in the World Bank, the United Nations, multinational organizations, Congress, and even the private financial community. We cannot expect even the largest and most effective private groups, such as the World Wildlife Fund, to carry the burden; they are just too small. International action will be needed if there is to be any hope of putting into effect more than a few of the wide array of excellent ideas contained in this volume.

Anyone concerned with biodiversity should own this book. It is not tightly organized, there are a few loose guns on deck, and there is often more inspiration than plan for action. Still, it is the one best source for information on the present state of biological diversity and for ideas concerning its maintenance and restoration.

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Books Received

Acoustics Source Book. Sybil P. Parker, Ed. McGraw-Hill, New York, 1988. viii, 333 pp., illus. $35. McGraw-Hill Science Reference Series. Series includes source books on communications, computer science, meterology, and nuclear and particle physics, all based on the *McGraw-Hill Encyclopedia of Science and Technology* (New York, 1987).