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BOOK REVIEWS

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BioDiversity.—E. O. Wilson, editor. 1988. National Academy Press, Washington, DC. 251 p.

Biodiversity, a term coined in the 1980s, has not exactly become a household word, but it has rapidly become somewhat of a buzzword among conservationists, biologists, and even policy makers. In the early part of the decade, most biologists thought of biological diversity, when they thought of it at all, in terms of symbols such as H and S and equations such as the Shannon-Wiener index. Now biological diversity is thought of in the context of tropical rainforests, a mass extinction event unparalleled in 65 million years, and a newly incarnated discipline—conservation biology.

The seminal event in this metamorphosis was the September 1986 National Forum on BioDiversity sponsored by the National Academy of Sciences (NAS) and the Smithsonian Institution (SI). The forum brought together, over 4 days, leading biologists and conservationists to discuss the status and trends of the diversity of life on Earth. The symposium was widely publicized and the attendants numbered into the thousands including those linked through teleconferences. For the first time, media attention was directed towards a problem that had been considered arcane and somewhat peripheral to the business of the world.

An important, but less celebrated, aspect of the event was the shortening of the cumbersome scientific term "biological diversity" into the catchy phrase "biodiversity." This abbreviation was coined by Walt Rosen, NAS planner of the program, who wistfully noted the loss of the term "logical" in creating the buzzword.

BioDiversity, edited by Harvard's esteemed biologist E. O. Wilson, is the proceedings of the forum. It features 57 chapters that cover the gamut from biology to theology, from the practical to the esoteric, and includes 61 authors from A (Ashton) to Z (Zedler). Following the excellent overview chapter by Wilson, the book is divided into 13 sections, representing the various panels of the forum. The chapters are short enough for bedtime reading, but disturbing enough to prevent sleep.

The book is diverse, representing the breadth encompassed by a single term for the entire range of living creatures with their various interactions and processes. The single unifying feature of the book and of the field is the crisis atmosphere, with panel titles such as: "Challenges to the preservation of biodiversity"; Diversity at risk"; "Science and technology: how can they help?"; "Restoration ecology: can we recover lost ground?"; "Alternatives to destruction"; and "Present problems and future prospects."

Undoubtedly, biodiversity is in a state of crisis. Just as we are learning from Terry Erwin's study of insects in the canopy of Peruvian rainforests (chapter 13) that there may be some 50 million species on the Earth as opposed to the current estimate of 3 to 5 million, we are also realizing that we will never know, even to an order of magnitude, the true number of species with whom we share the planet. Biodiversity is being destroyed at a catastrophic pace in what is but a tick of the ecological time clock.

Norman Myers (chapter 3) presents data on the rate of deforestation (1%/year) and degradation (another 1%/year) of the remaining tropical forests. Using biogeography to extrapolate rates of extinction, Myers agrees with Wilson's earlier estimate of extinctions of some 10,000 species annually (compared with a background rate of one extinction/year). Based on present rates of deforestation, he projects the extinction of 15% of all plant and animal species in Amazonia by the year 2000. Beyond that, it only gets worse. Such dire projections were largely disbelieved in the 1970s when Myers first started making them. Yet Wilson, in his overview chapter, points out that these "doomsday scenarios" may in fact be underestimates.

Why is biodiversity being lost in all forms and in all places on the Earth? Paul Ehrlich in his usual direct fashion pinpoints the reason (chapter 2): "The primary cause of the decay of organic diversity is not direct human exploitation or malevolence, but the habitat destruction that inevitably results from the expansion of human populations and human activities." The world's human population is about 5.5 billion, some three times the amount at the beginning of this century. The population is expected to double within the next century. This entirely likely event will undoubtedly result in the extinction of much of the Earth's biota, even in the next few decades, "if the scale of human activities continues to increase," according to Ehrlich.

"What can be done?" asks Wilson in the final section of his opening chapter. The remainder of the book attempts to answer this question. It explores the state of biodiversity and provides many examples of what is being done and what else should be done. The volume includes all of the biodiversity "superstars"—Wilson, Ehrlich, Myers, Dan Janzen, Peter Raven, and Tom Lovejoy—biologists who look at the big picture and garner what little media attention comes to this field. It also includes chapters by many of the lesser known workers in the trenches and on the front lines of conservation—Mario Ramos, Bill Burley, Chris Uhl, Jerry Franklin, and a host of others.

The diversity of authors reflects the diversity of the battle to save biodiversity. Not only are there biologists, but also economists, anthropologists, agronomists, a paleontologist, a pharmacist, a film maker, philosophers, and policy makers. In addition to the expected academics and scientists from zoos, botanical gardens, and arboretums, there are authors from conservation organizations, U.S. government agencies, and the World Bank. The lack of authors from the traditional wildlife management community indicates their separation from the new conservation biology agenda.

The book is representative of the biodiversity conservation movement in other less positive ways as well. Only four of the authors are women and two of these

are junior coauthors. Despite the international orientation of the book, all but a handful of authors are American. It is also unfortunate that at the time no U.S. politician was competent to speak about biodiversity (a handful are now).

Typical of the biodiversity debate, the focus is almost entirely on terrestrial ecosystems. Carleton Ray, the author of the only chapter on marine diversity (chapter 4) complains about this, and rightly so. (See Les Kaufman's editorial: Marine biodiversity: the sleeping dragon [Conserv. Biol. 2:307–308, 1989] for more about the marine situation.) There is nothing on freshwater systems; it is unfortunate that Ruth Patrick of the Philadelphia Academy of Science was not among the participants.

Much of the concern about the biodiversity crisis is focussed on tropical rainforests—the 7% of the land surface that has more than 50% of the above-ground species (recent discoveries suggest that the soil microflora may be richer in the temperate zone). Wilson acknowledges this, pointing out that most of these diverse forests will be gone in the next century and that because of their combination of diversity and precarious status, "the rain forests serve as the ideal paradigm of the larger global crisis."

Although there are chapters on other ecosystems, including Dennis Murphy's "challenges to biological diversity in urban areas" (chapter 7), I am concerned that most people equate biodiversity only with tropical forests. Is a hectare of tropical forest more valuable than a hectare of arctic tundra? By some measures it is, if one only counts species and looks for economic products that can be developed from "biological resources." Yet, measured on an ecosystem scale the tundra is at least of equal value, especially if one is standing in Alaska.

Despite the grave nature of the biodiversity crisis, the authors of this book are not ready to concede defeat. Norman Myers has elsewhere described the biodiversity crisis as something unique to our generation—no previous generation had to deal with it, and if we fail, there will be nothing left to do except pick up the pieces. *BioDiversity* offers a series of solutions, including raising the awareness of the value of biodiversity, developing new foods and pharmaceuticals, inventory and monitoring, ex situ technology, ecological restoration, agroecology, sustainable forestry, policy, and education. Few of these solutions address the root causes of biodiversity loss—overpopulation and habitat destruction. William Conway, in answering his own question "Can technology aid species preservation?" (chapter 31) reminds us that "most losses of biological diversity are quite beyond human ability to repair." In fact, the inappropriate application of technology is a major contributor to the destruction of biodiversity.

The number of chapters on philosophy and ethics may be surprising to the hard core scientist. More remarkable is the number of scientists who end their presentations talking about ethics. In his chapter on intensive technologies for endangered species in captivity (chapter 33), Ulysses Seal ends up with a discussion of ethics and value systems. Ehrlich contends that "scientific analysis points toward the need for a quasi-religious transformation of contemporary values." Wilson concludes, "In the end, I suspect it will come down to a question of ethics. . . ." But maybe this is not so surprising, when we remember that it was a biologist, Aldo Leopold, who enumerated "the land ethic."

However, discussion of ethics must face the reality of a world where hundreds of millions of people are poor and malnourished. James Nations (chapter 8) starts to address this in his chapter, "Deep ecology meets the developing world." Americans working in the tropics are finally carrying home the message that international development will and must continue and that it is really poverty that is the enemy of conservation in much of the world. Mexican biologist Mario Ramos puts it most directly (chapter 48), "What has been slow to come, in my opinion, is recognition that the preservation of the biological diversity in the world is a shared commitment between rich and poor countries and that major responsibilities fall into the hands of the countries where this diversity is found. Since the greatest diversity exists in the tropical areas of the world, these responsibilities generally lie within the developing countries. In these countries, however, social, economic and political problems often make conservation of their diversity very difficult. The riddle of balancing development; stability in economic, social and political terms; and conservation of their natural resources is difficult for any of these countries to solve by themselves."

BioDiversity points out the importance and enormity of the challenge of biodiversity conservation. It shows a diversity of solutions, from a diversity of perspectives. Biologists alone can not stop the mass extinction. Yet it is incumbent on biologists to lead the way, if for no other reason than because no one else will. *BioDiversity* is the Bible of the biodiversity conservation movement. Along with the more narrowly focussed texts in conservation biology, edited by Michael Soulé (1980 and 1986), this book is required reading for any biologist interested in conservation. These books have already been used as texts for many new programs in conservation biology that are springing up around the U.S. They also are critical resources to conservationists in foreign countries, where access to information is a tremendous problem. One doesn't have to be a biologist to read this book, and if it is only read by biologists, its value will be minimized.

E. O. Wilson has been called the "Darwin of the 20th century." Having mastered the fields of systematics and biogeography, he created the new field of sociobiology. His personal ethics added to his scientific understanding led to his influential popular text *Biophilia.* Wilson has applied biogeography and systematics towards understanding what he calls one of the key problems of science as a whole: "the magnitude and control of biological diversity." Now he's devoting much of his tremendous talent and energy to trying to arrest the destruction of biodiversity before the evolutionary process is forever altered. We all owe a tremendous debt to Wilson that can only be repaid by increasing our own efforts in conservation.

Since the 1986 Forum on BioDiversity there have been many positive developments. The destruction of tropical rainforests is now "common knowledge." There are major efforts to make sustainable development (development that does not deplete the natural resource base) the centerpiece of U.S. international assistance.

The World Bank has created an environment department. Debt-for-nature swaps, in which debt relief is exchanged for conservation action, are taking place in more than a dozen countries. Congressman Jim Scheuer's (D-NY) national biological diversity bill, to create and implement a biodiversity conservation policy for the U.S., is moving through Congress. Conservation biology has emerged as an active science, including a professional society with thousands of members, and a whole spate of newly oriented graduate programs. The National Science Foundation put forth a special $3.5 million request for proposals in conservation biology and approved a plan for a major initiative in biodiversity research and education. Plans are being made for a global convention (treaty) on biodiversity.

Events like the greenhouse effect and the ozone hole are front page news. The environment has never been higher on the political agenda. Fully one-third of the points of the communiqué from the 1989 summit of the Western political leaders discussed the environment (although the phrase "biodiversity" never made the text).

Despite this, human population growth continues to soar exponentially. The pace of habitat destruction has not slowed. The extinction rate, already 1,000 to 10,000 times greater than before human intervention, accelerates unchecked. Biodiversity is not yet in the everyday language although endangered species are in the daily news.

The politicians and the public are not yet aware that a mass extinction event is occurring, but related issues have caught their attention. Tom Lovejoy has called the 1990s the pivotal decade with respect to our global environment. If we do not change, by the next century "the momentum of the problems coupled with the inertia of Society will render the problems insuperable" (T. Lovejoy, Will unexpectedly the top blow off?, Bioscience 38:722–726, 1988). I recently spoke with E. O. Wilson, who said that recent developments have made him optimistic, but then he cautioned, "I'm an optimist by nature."—DAVID E. BLOCKSTEIN, American Institute of Biological Sciences, 730 11th Street, N.W., Washington, DC 20001.

Editor's note—Annual review series like *Current Ornithology* provide a broad array of essays and are designed not only to synthesize current knowledge for area specialists, but also to provide introductory information for the broader ornithological community. In an effort to assess how well *Current Ornithology* serves the second function, Scott Robinson asked his graduate seminar students to read the book, lead discussions about each chapter, and write an evaluation of each chapter. This review presents the results of that effort.—M.F.L.

Current Ornithology: Volume 6.—Dennis M. Power, editor. 1989. Plenum Press, New York. xi + 332 p. hardback $59.50. Source: Plenum Publishing Corporation, 233 Spring Street, New York, NY 10013.

The volumes in this series continue to offer review articles of a wide variety of subjects in ornithology. The emphasis in this volume is clearly on migration (three chapters), but there are also articles on parental investment and sex ratios, plumage evolution, and conservation of the California Condor, *Gymnogyps californianus*. Teachers of ornithology classes often use the articles in this series as "instant lectures" because many reviews cover broad subjects such as geographic variation and interspecific competition. The six chapters of this volume, however, mostly cover narrower topics of more interest to specialists. The topic of olfactory orientation (chapter 6), for example, often receives only a passing mention in most ornithology textbooks and classes. This review is designed to evaluate the usefulness of this volume for graduate students who often must decide whether to pay the rather high price or pay the same amount for two or three regular journals. Each chapter review was written by a student after leading a discussion group during a lab meeting.

The first chapter, "Mortality patterns, sex ratios, and parental investment in monogamous birds" by Randy Breitwisch, makes it clear that we really don't know why the sex ratios of most monogamous species are male-biased. This topic has considerable interest for sociobiologists and for the conservation biologists who are increasingly finding severely male-biased sex ratios of breeding birds in fragmented landscapes (J. Faaborg, pers. comm.). Breitwisch challenges Trivers' (Parental investment and sexual selection. *In* B. Campbell [ed.], *Sexual selection and the descent of man,* 1972, Aldine, Chicago) classic assertion that sex ratios are male-biased because females invest more in offspring than males and hence have higher mortality rates. Instead, he proposes that female mortality rates may be higher for postfledgling juveniles and for females outside the breeding season. Recent work on social status and winter habitat selection suggests that nonbreeding season mortality is likely to be more important than generally realized. Breitwisch's discussion of the possible mortality associated with female dispersal is particularly well documented and convincing.

This chapter, which has over 200 references, offers an extraordinarily thorough treatment of the literature. Nevertheless, few studies present quantitative data on male and female investment, especially for tropical birds. Males are often not given credit for their investment in territorial defense, mobbing predators, and caring for fledglings. Breitwisch uses his own data on Northern Mockingbirds (*Mimus polyglottus*) to argue that males of some species invest more than females in offspring and assume greater risks in defense against predators. As the limiting sex, females may be able to demand high parental investment of their mates. The many references to European studies of nest defense against predators suggest that North American behavioral ecologists have lagged behind their European counterparts in the recognition of the critical importance of predation in all aspects of behavioral ecology.

Breitwisch's approach effectively combines ecological and behavioral studies with population biology. However, some arguments that Breitwisch presents may be overstated. Do we really know if sex ratios become male-biased after fledglings become independent? Given the formidable problems of sexing nestlings in most species, this conclusion seems tenuous. Such questions are stimulating, however, and could easily lead to new research on the subject.

In chapter two, "The evolution of conspicuous and distinctive coloration for communication in birds," G. S. Butcher and S. Rohwer present a huge and complex comparative review of a topic that has interested biologists since Darwin. After defining terms and outlining the history of this subject, they describe patterns of bright coloration and develop three "rules" of avian dimorphism: (1) when sexual dimorphism occurs, males are more colorful than females, (2) when age classes differ with respect to color, adults are more colorful than juveniles, and (3) when seasonal patterns occur, birds are more colorful during the breeding season. These rules may seem obvious, but documenting these patterns required an extensive literature review (over 200 references are listed). Students of plumage phenomena may find Butcher and Rohwer's review to be a handy single guide to the literature. Passing attention is given to Baker and Parker's hypothesis that colorfulness evolved as a signal to predators that males are unprofitable prey because they are more likely to be vigilant than females or young. This hypothesis is often not taken too seriously by North American investigators, but has been challenged by European scientists.

Butcher and Rohwer examine the three rules of avian dimorphism in light of the "threat hypothesis," which argues that "conspicuously colored individuals have evolved because they are better at defending resources." As such, the threat hypothesis is an extension of previous status signaling hypotheses. Butcher and Rohwer then evaluate, in exhaustive detail, competing hypotheses and the evidence for each. The authors clearly favor the threat hypothesis, but argue that progress in the field has been inhibited by a failure to take into account each of the viable alternative hypotheses. Indeed, the need to elucidate and test the multitude of competing hypotheses for the evolution of plumage dimorphism has preoccupied one of the students in the group (D. Enstrom) for several years. The greatest value of this review therefore appears to be the identification of hypotheses and the emphasis on future research needs.

The third chapter, "Atmospheric structure and avian migration" by Paul Kerlinger and Frank R. Moore, reviews atmospheric structure and how birds may respond to its effects in the timing and altitude of migration. The authors provide information on how turbulence, winds, temperature, and relative humidity vary in daily and seasonal patterns and how these factors would affect migrating birds. The importance of each of these components of atmospheric structure depends on the mode of flight (powered or soaring), speed of flight, and body size of the species under consideration. Kerlinger and Moore conclude that species using powered flight should be nocturnal migrants, whereas soaring species should be diurnal. Predicting the altitude of migration is not nearly as simple, because wind speed and direction are important variables. Based on information obtained from their literature review, most species followed the predicted patterns. Several exceptions are mentioned which, in most cases, can be explained in terms of atmospheric structure. Atmospheric structure, predator avoidance, and the need to forage during daylight hours may have been selective forces acting together in the evolution of nocturnal migration. Of these three hypotheses, however, atmospheric structure best explains diurnal migrations and the altitude of migration.

None of the students had any prior familiarity with this topic, which reduced critical discussion. Everyone agreed, however, that the chapter was well written, informative, and provided abundant material for at least part of a potential lecture on migration in an ornithology class. One rather obvious error was found: when "mps" is first introduced, it is defined as "miles per second" rather than "meters" (p. 114).

In chapter four, "Passerine migration between the Palaearctic and Africa," Gábor Lövei provides a comprehensive treatment of the adaptations of Palaearctic migrants. In the past two decades there has been a tremendous increase in research on the ecology and conservation of species that migrate between the temperate zone and the tropics. These species provide an important focus for conservation efforts between the more industrialized areas of North America and Eurasia and the less developed tropical countries where deforestation and desertification have become severe problems.

Lövei's review emphasizes resource use, social systems, condition, and seasonal movements of migrants in the Mediterranean and Africa. The author makes frequent comparisons between Palaearctic and Nearctic migration systems. As is the case for many Nearctic migrants, populations of at least 15 species of Palaearctic migrants are declining rapidly, possibly because of the prolonged Sahel drought and the resulting desertification of savanna habitats where Palaearctic migrants concentrate disproportionately. Lövei also draws an interesting parallel between the extended transoceanic flights of many Neotropical migrants and the trans-Saharan flights made by many Palaearctic migrants, especially those migrating from European breeding areas.

Lövei concludes that migrants tend to avoid the interior of African rainforests during winter, but argues that rainforest may be used extensively as stopover sites for premigratory fattening. In general, it appears that Palaearctic migrants "have evolved to use seasonally available resources in places unsuitable for continuous use" (p. 167). Lövei makes a strong argument for the priority of conservation research, especially in identifying links in the "chain of areas necessary to complete" the annual cycles of migrants. It is disturbing, if not surprising, that the problems faced by Palaearctic migrants differ only in detail from their Nearctic counterparts. This chapter provides both details of how Palaearctic systems work and a perspective on similar issues in the Americas.

In chapter five, "Biology and conservation of the California Condor," Noel and Helen Snyder produced a monograph-length (97 page) review of both historical and modern developments relating to conservation efforts for the condor. The review is broken into three major sections: the history of biological studies, conservation efforts, and an assessment of the future of the condor. In the section on the history of biological studies, the authors attempt to trace the development and accumulation of biological information in the time frame of eras designated by the leading condor biologists of the time. This historical approach traces the beliefs and opinions of each authority and identifies

the sources of data that each had available. The findings and developments of the Koford, McMillan, Sibley, and Wilbur "eras" are outlined, identifying the strengths and weaknesses of the data obtained from each period.

The authors then draw upon their 7 years of field experience with the condor project to present a detailed outline of the progress of the modern research effort (since 1980). In particular, the Snyders emphasize the advances made since it has been possible to census condors accurately using photos (a technique currently used to study macaws by Charlie Munn in South America), and to the much delayed implementation of radiotelemetry work.

In the section on condor conservation, the Snyders review the policies and often controversial politics involved in the efforts to save the condor. The authors trace the development of the condor as a wilderness symbol and the belief that the condor was very intolerant to the presence of humans. They further discuss how these views hindered conservation efforts. Again there are detailed accounts of the events of the modern era, up through the crisis period of 1985–1986, when it became obvious that the California Condor was about to become extinct in the wild. The final section addresses what may be in store in the future for the California Condor, including a discussion of the prospects for captive breeding and eventual release of condors back into the wild.

This paper should appeal to a broad range of biologists. The reconstruction of the accumulation of biological information is sufficient to familiarize persons not intimately associated with the project. On the other hand, the descriptions of the events of the recent program are provided in sufficient detail so that even persons familiar with the condor and its recovery program are likely to gain some new insight into condor biology and the sequence of events leading to the eventual capture of the last wild condor. Furthermore, the lesson of how bureaucracy can slow and hinder progress, even for organisms in such a precarious state, is one that should be closely scrutinized so that such occurrences can be circumvented when we face similar situations with other organisms in the future. Perhaps above all, the Snyders' paper serves as a cautionary tale for students pondering work with controversial and emotionally charged issues such as endangered species management. Conservation biologists have to deal with whole sets of problems that "ivory tower" biologists never have to face.

Chapter six, "Olfactory orientation of birds" by Jerry Waldvogel, presents what must be the most exhaustive review ever undertaken of this controversial subject. Birds have usually been considered to have a poor sense of smell ("microsmotic" in the jargon) relative to other classes of vertebrates. For this reason, the results of a group of Italian researchers suggesting that birds can navigate by smell were greeted with considerable skepticism. Waldvogel, however, argues convincingly from a review of the physiological literature that birds are actually quite sensitive to some odors. He then proceeds to discuss possible sources of predictable odor dispersion that could be used in avian orientation. Many birds apparently use odors as local landmarks and for foraging; procellariids, for example, locate food by using a zigzag upwind flight to localize an odor source.

In the heart of the chapter, Waldvogel details the often bewildering array of experiments designed to demonstrate that pigeons can use olfaction in true navigation. Some of the experiments developed by the Italian researchers are quite ingenious, but all seem to have problems; none have been replicated in North America and only a few have been replicated in Germany despite intensive experimentation by Waldvogel among others. The surgical procedures used to manipulate olfactory senses are particularly complex; Waldvogel, for example, refers to one operation as a "commissurotomy." Similarly, many attempts have been made to transplant pigeons between countries. Fortunately for the uninformed reader, there are frequent summaries of the conclusions to be drawn from each set of experiments.

Waldvogel concludes that pigeons raised in Italy do use olfaction for homing, but those in many German and all North American lofts tested do not. Therefore, olfaction is not "universal" or "essential" as has been argued by some researchers. Perhaps olfaction is one of many back-up orientation systems that can be used wherever there are strong and predictable odor gradients. Waldvogel concludes with a plea for further experimentation designed to test for long-range rather than for local olfactory navigation.

Because no one in our lab group studies avian orientation, we found this paper more useful as a source of information than as a guide to new research directions. Certainly, parts of the review could be used in an ornithology class, especially given the tendency to downplay olfaction in most texts. Several diagrams of olfactory orientation (e.g., figures 4 and 8) would be ideal for ornithology lectures and may find their way into new textbook editions.

Taken as a whole, the book succeeds as a forum for diverse review articles that are both informative and opinionated. There are few other outlets for such papers. It is too bad that so few graduate students (or professors for that matter) will be able to afford to buy the books in this series. Most chapters suggest new research directions and needs that could be very influential to students seeking research directions.—SCOTT K. ROBINSON, JAMES R. HERKERT, CHERYL TRINE, DAVE ENSTROM, KRIS M. BRUNER, DAN NIVEN, AND MIGUEL MARINI, Department of Ecology, Ethology, and Evolution, University of Illinois, 505 S. Goodwin, Urbana, IL 61801 and the Illinois Natural History Survey, 607 E. Peabody Dr., Champaign, IL 61820.