

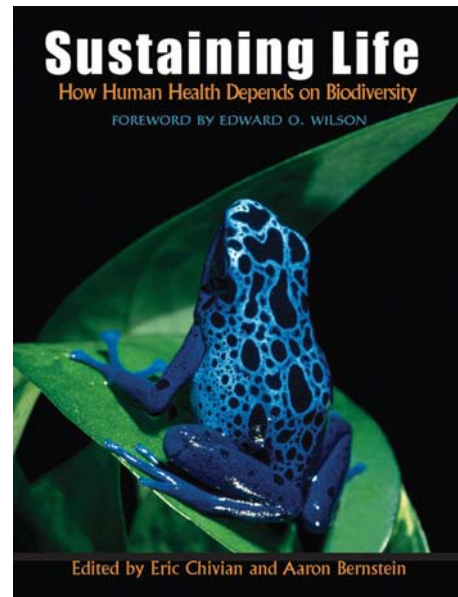
Book Review

Biodiversity and Human Health

***SUSTAINING LIFE: HOW HUMAN HEALTH DEPENDS ON BIODIVERSITY*, ERIC CHIVIAN AND AARON BERNSTEIN (EDITORS), 2008, NEW YORK: OXFORD UNIVERSITY PRESS, 542 PP, ISBN: 978-0-19-517509-7**

The rate of species loss today is approaching catastrophic levels. Scientists project that over the next two decades, more than one million species of plants and animals will become extinct. E.O. Wilson has estimated, “The rate of loss may exceed 50,000 a year, 137 a day...this rate, while horrendous, is actually the minimal estimate, based on the species/area relationship alone....” (Kellert and Wilson, 1993, p. 16). Over-exploitation of species, habitat fragmentation and destruction, and exotic species introduction have been the most important factors of biodiversity loss; we refer to them as the “Evil Trio.” More recently, three other factors have proven devastating to populations and ecosystems, adding to the list: pathogen pollution, global toxification, and global environmental change linked to climate; we refer to all these as the “Savage Sextet” of biodiversity loss.

In this context, the release of “*Sustaining Life: How Human Health Depends on Biodiversity*” comes at an exceptionally opportune time. Eric Chivian and Aaron Bernstein have put together an outstanding 542-page compendium that outlines, in rich detail, our dependency on the variety of life on Earth—its genes, species, populations, and ecosystems. Setting the stage with a Foreword by E.O. Wilson, the father of biodiversity, and a Prologue by former United Nations Secretary General Kofi Annan, the book includes 10 chapters and 3 appendices written by experts in their fields. The first chapter, “What Is Biodiversity?” provides a historical, evolutionary, and biological account of biodiversity with many rich examples. There is a



substantial discussion on how we estimate species numbers and extinction rates, how the latter have changed over geological frames since the arrival of humans, and outlines why analyses need to include details on losses at the population and genetic levels. A well-known example of recent extinctions includes the Pacific Island birds. From 136 species known to exist in the Hawaiian Islands before Captain Cook’s arrival in 1778, today only 11 extant species have a relatively safe future.

Chapter 2, “How Is Biodiversity Threatened by Human Activity?” sets the stage outlining the fundamental anthropogenic threats. Habitat destruction and species loss have led to ecosystem disruptions that include, among other impacts, the alteration of disease transmission patterns (i.e., emerging diseases), the accumulation of toxic pollutants, and the invasion of alien species and pathogens. The authors pay special attention to the profound role of climate change on all ecological processes,

including increased precipitation in some regions and drought in others; increased erosion of the coastal zone with rising sea levels; and the inability of many species to adapt to the relatively rapid changes in climatic regimes, potentially resulting in mass extinctions. An example of this phenomenon can be seen in a recent article: Jenouvrier et al. (2009) reported that the accelerated rates of melting of Antarctic ice caps could cause the extinction of emperor penguins (*Aptenodytes forsteri*) by the end of the century. Many other detailed examples were given in the book, including major geographic range changes of many species on land (e.g., to higher latitudes) and at sea (to colder waters). We are already seeing warmer temperatures leading to massive coral bleaching worldwide. Climate change and other human activities are producing marine dead zones, acidification of seawater, large-scale forest pest infestations, drought, and decline of coastal wetlands.

Chapter 3, “Ecosystem Services,” provides an overview of an emerging global interest in valuing ecosystems and biodiversity, and their benefits to humans. Detailed descriptions of the microbial world, as one of the most biodiverse and adapted groups on Earth, provide amazing facts. A recent study demonstrated that the skin of six humans harbors 182 bacterial species of 91 genera with only 4 species shared by all six subjects. This research is just scratching the tip of a gigantic iceberg. Similarly, unpublished data from our group demonstrated that cloacal swabs collected from 150 brown pelican (*Pelecanus occidentalis*) chicks in five islands in the Sea of Cortez, Baja California, Mexico, harbored over 1,200 isolates of 262 different bacterial species, from which 9 are being characterized as new species [Aguirre et al., 2009, unpublished data]. The ecosystem services provided by biodiversity are innumerable, including: clean air; purification of water; flood mitigation; erosion control; binding and detoxifying pollutants in soils, sediments, and water; controlling pests and pathogens; storing carbon; and stabilizing climate. The authors also discuss esthetic, cultural, recreational, emotional, intellectual, and religious values of biodiversity. If we are to alleviate the numerous threats to ecosystem services, a proactive and transdisciplinary approach is necessary to address the trends of rapid ecological degradation and its effects on human health.

Chapter 4, “Medicines from Nature,” provides a fascinating story of drug development; it also serves as a compendium of natural substances and chemicals, extracted from plants and animals, playing an important role

in traditional medicine and drug discovery, including quinine, aspirin, artemisinin, Cat’s claw, *Jaborandi*, and *Lapacho*, to name a few. The chapter also reviews the role of natural products in development of insecticides and fungicides, including plant-derived compounds such as nicotine, rotenone, and carbamates, and even the use of some invertebrates, like the medicinal leech and canine hookworm, that have benefited humanity through “in vivo” clinical application. Chapter 5, “Biodiversity and Biomedical Research,” provides a wonderful overview of the profound historical role of diverse animals and microbes in biomedical discoveries. In addition to historically important roles in basic medical understanding of anatomy, genetics, immunity, many modern therapies, such as tissue regeneration, neurogenesis, and stem cell research for diseases such as Parkinson’s and diabetes, depend fundamentally on research with biodiversity.

Chapter 6, “Threatened Groups of Organisms Valuable to Medicine,” is the heart of the book. The diversity of peptide compounds in the venoms of cone snails (numbering about 500 known species), inhabiting tropical coral reefs, is so abundant that it may be similar to that of alkaloids in higher plants and secondary metabolites in bacteria. However, most of these species are not protected or studied in detail to understand their fate on this planet (Aguirre et al., 2002). Species cited in this chapter as being of critical importance to human medicine include amphibians, polar bears, and sharks, and the authors conclude that the threats to their survival, in the form of pollution and climate change, may also have disastrous consequences for human health—in particular for diabetes, obesity, osteoporosis, and renal disease. The organisms presented in this chapter are just a small subset of the biodiversity that must be conserved—for their beauty, and genetic, molecular, morphophysiological, biochemical, and behavioral complexity. We, as humans, have so much more to learn about the critical role these species play in both complex ecological processes and in our own health. Unfortunately, we are losing the time necessary to reverse this alarming trend of population decline and extinction.

Chapter 7, “Ecosystem Disturbance, Biodiversity Loss, and Human Infectious Disease,” reviews the evidence that increases in vector-borne and other diseases in humans and animals occur as a result of anthropogenic changes in the planet, such as urbanization, deforestation, agricultural development, and climate change. Disease can be also a threat to biodiversity. Diseases that jump between species—

including wildlife, domesticated animals, and humans—are emerging around the world. For instance, the Ebola virus, which broke out in villages several years ago in Zaire, is pushing gorillas to extinction in western Africa; according to the most comprehensive population survey to date, it has killed up to 95% of the gorillas in some areas. The lethal hantavirus of the American southwest moves from rodents to people. More recently, the avian influenza virus has surprised many epidemiologists' rules by jumping from chickens straight to humans, and calling world attention to a potential pandemic with the H1N1 outbreak in Mexico. As habitat becomes more compressed, with migration routes cut off, small species' gene pools are stranded in isolated, habitat fragments. The health problems observed in free-ranging wildlife today resemble those seen in captive wildlife. Species now are vulnerable to encroachment, malnutrition, environmental pollutants, and epidemics from domestic animals and humans. Furthermore, the continuous degradation of ecosystems is leading to increased stress, immunosuppression and, therefore, greater susceptibility to disease. Disease can be catastrophic to a diminished and already stressed population. Amphibian chytridiomycosis is a recent example of a disease becoming the leading factor in many local extinctions and in the global frog decline.

Chapter 8, "Biodiversity and Food Production," discusses the dependency of agriculture to life on the planet, including benefits such as disease control, insect pest control, pollination from birds and bats, and the importance of soil biota in soil ecosystem services. The chapter includes a description of the impact of livestock production on biodiversity, and more sustainable ways to raise cattle. Aquaculture, including mariculture, has several impacts on the environment through pollution with antibiotics, growth-stimulating nutrients, and diseases. These factors, together with mangrove destruction and introduction of exotic species into new habitats, may lead to depletion of wild populations. The authors also discuss approaches to more sustainable systems, including increased consumption of farmed herbivorous fish, better plant-based feed for carnivorous fish, and land-based mariculture facilities to reduce the problems mentioned above.

Perhaps surprisingly to some, Chapter 9, "Genetically Modified Foods and Organic Farming," highlights the benefits of GMOs (Genetically Modified Organisms), including reduced and more environmentally sound

agrochemical use; soil conservation; and increased yield and removal of organic compounds. Of course, there are risks associated with GMOs, such as the introduction of exotic species or genes into the system, and effects in non-target organisms. The section on organic farming asks: Is it better for human health and the environment? Can organic farming help answer some of the food problems in the world, including sufficient calorie production? A number of boxes outline examples of integrated crop/livestock systems and organic farming as potential solutions to a sustainable agriculture.

Finally, Chapter 10, "What Individuals Can Do to Help Conserve Biodiversity," addresses the "ecological footprint" of humans as a complicated and politically charged concept. The Millennium Ecosystem Assessment has yielded a major document on the status of natural resources on planet Earth. We are already above the planet's carrying capacity, and most people don't comprehend the impact of our consumption practices. The authors focus on changing lifestyles to minimize that "ecological footprint," and on raising awareness at home, in the work place, or through support organizations that are working to conserve biodiversity. Use, re-use, and recycle are described as potential solutions for a society geared to high consumption. Planting trees, lowering energy consumption, choosing appliances carefully, and conserving water all serve to moderate our impact on natural resources. At the end of the book, most of the solutions are oriented towards the developed world, and will be less useful for two-thirds of the planet.

To conclude, the book serves as an excellent reference book on why we should protect biodiversity for the benefit of human health. It is now *the* book to consult on how our health depends on biodiversity, and it will be widely used by biodiversity professionals, veterinarians, public health specialists, and students of the ecological and health sciences. A more user-friendly guide for the general public would be a welcome follow-up. While compelling, the human health justification for biodiversity conservation makes the book extremely anthropocentric. Now it's time to fill in the missing piece—how biodiversity depends on us.

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