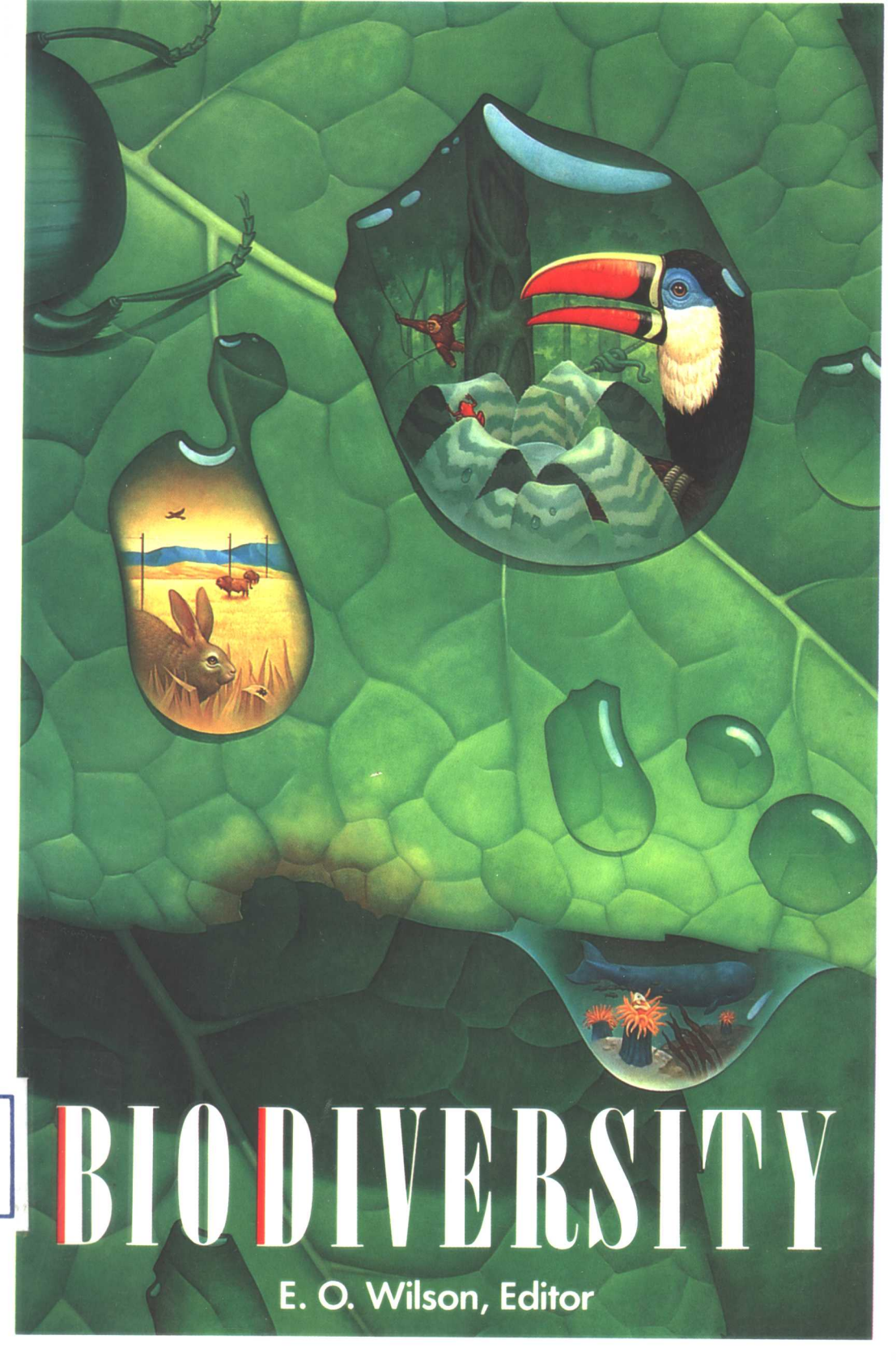

BIODIVERSITY

E. O. Wilson, Editor

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E. O. Wilson, *Editor*
Frances M. Peter, *Associate Editor*

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The National Forum on BioDiversity was developed by the Board on Basic Biology of the National Research Council's Commission on Life Sciences and by the Smithsonian Institution's Directorate of International Activities.

The views expressed in this book are solely those of the individual authors and are not necessarily the views of the National Academy of Sciences or of the Smithsonian Institution.

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EDITOR'S FOREWORD

The diversity of life forms, so numerous that we have yet to identify most of them, is the greatest wonder of this planet. The biosphere is an intricate tapestry of interwoven life forms. Even the seemingly desolate arctic tundra is sustained by a complex interaction of many species of plants and animals, including the rich arrays of symbiotic lichens. The book before you offers an overall view of this biological diversity and carries the urgent warning that we are rapidly altering and destroying the environments that have fostered the diversity of life forms for more than a billion years.

The source of the book is the National Forum on BioDiversity, held in Washington, D.C., on September 21–24, 1986, under the auspices of the National Academy of Sciences and Smithsonian Institution. The forum was notable for its large size and immediately perceived impact on the public. It featured more than 60 leading biologists, economists, agricultural experts, philosophers, representatives of assistance and lending agencies, and other professionals. The lectures and panels were regularly attended by hundreds of people, many of whom participated in the discussions, and various aspects of the forum were reported widely in the press. On the final evening, a panel of six of the participants conducted a teleconference downlinked to an estimated audience of 5,000 to 10,000 at over 100 sites, most of them hosted by Sigma Xi chapters at universities and colleges in the United States and Canada.

The forum coincided with a noticeable rise in interest, among scientists and portions of the public, in matters related to biodiversity and the problems of international conservation. I believe that this increased attention, which was evident by 1980 and had steadily picked up momentum by the time of the forum, can be ascribed to two more or less independent developments. The first was the accumulation of enough data on deforestation, species extinction, and tropical biology to bring global problems into sharper focus and warrant broader public exposure. It is no coincidence that 1986 was also the year that the Society for Conservation Biology was founded. The second development was the growing awareness of the close linkage between the conservation of biodiversity and economic development. In the United States and other industrial countries, the two

are often seen in opposition, with environmentalists and developers struggling for compromise in a zero-sum game. But in the developing nations, the opposite is true. Destruction of the natural environment is usually accompanied by short-term profits and then rapid local economic decline. In addition, the immense richness of tropical biodiversity is a largely untapped reservoir of new foods, pharmaceuticals, fibers, petroleum substitutes, and other products.

Because of this set of historical circumstances, this book, which contains papers from the forum, should prove widely useful. It provides an updating of many of the principal issues in conservation biology and resource management. It also documents a new alliance between scientific, governmental, and commercial forces—one that can be expected to reshape the international conservation movement for decades to come.

The National Forum on BioDiversity and thence this volume were made possible by the cooperative efforts of many people. The forum was conceived by Walter G. Rosen, Senior Program Officer in the Board on Basic Biology—a unit of the Commission on Life Sciences, National Research Council/National Academy of Sciences (NRC/NAS). Dr. Rosen represented the NRC/NAS throughout the planning stages of the project. Furthermore, he introduced the term *biodiversity*, which aptly represents, as well as any term can, the vast array of topics and perspectives covered during the Washington forum. Edward W. Bastian, Smithsonian Institution, mobilized and orchestrated the diverse resources of the Smithsonian in the effort. Drs. Rosen and Bastian were codirectors of the forum. Michael H. Robinson (Director of the National Zoological Park) served as chairman of the Program Committee, organized one of the forum panels, and served as general master of ceremonies. The remainder of the Program Committee consisted of William Jordan III, Thomas E. Lovejoy III, Harold A. Mooney, Stanwyn Shetler, and Michael E. Soulé.

The various panels of the forum were organized and chaired by F. William Burley, William Conway, Paul R. Ehrlich, Michael Hanemann, William Jordan III, Thomas E. Lovejoy III, Harold A. Mooney, James D. Nations, Peter H. Raven, Michael H. Robinson, Ira Rubinoff, and Michael E. Soulé. David Johnson at the New York Botanical Garden was very helpful in verifying some of the botanical terms used in this book. Helen Taylor and Kathy Marshall of the NRC staff and Anne Peret of the Smithsonian Institution assisted with the wide variety of arrangements necessary to the successful conduct of the forum. Linda Miller Poore, also of the NRC staff, entered this entire document on a word processer and was responsible for formatting and checking the many references. Richard E. Morris of the National Academy Press guided this book through production.

The National Forum on BioDiversity was supported by the National Research Council Fund and the Smithsonian Institution, with supplemental support from the Town Creek Foundation, the Armand G. Erpf Fund, and the World Wildlife Fund. The National Research Council Fund is a pool of private, discretionary, nonfederal funds that is used to support a program of Academy-initiated studies of national issues in which science and technology figure significantly. The NRC Fund consists of contributions from a consortium of private foundations including

the Carnegie Corporation of New York, the Charles E. Culpeper Foundation, the William and Flora Hewlett Foundation, the John D. and Catherine T. MacArthur Foundation, the Andrew W. Mellon Foundation, the Rockefeller Foundation, and the Alfred P. Sloan Foundation; the Academy Industry Program, which seeks annual contributions from companies that are concerned with the health of U.S. science and technology and with public policy issues with technological content; and the National Academy of Sciences and the National Academy of Engineering endowments. The publication of this volume was supported by the National Research Council Dissemination Fund, with supplemental support from the World Wildlife Fund. We are deeply grateful to all these organizations for making this project possible.

Finally, and far from least, Frances M. Peter marshalled the diverse contributions in the present volume and was essential to every step of the manuscript editing process. The cover for *Biodiversity* was derived from a forum poster designed by artist Robert Goldstrom.

E. O. WILSON

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BIODIVERSITY

CHAPTER

1

THE CURRENT STATE OF BIOLOGICAL DIVERSITY

E. O. WILSON
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Biological diversity must be treated more seriously as a global resource, to be indexed, used, and above all, preserved. Three circumstances conspire to give this matter an unprecedented urgency. First, exploding human populations are degrading the environment at an accelerating rate, especially in tropical countries. Second, science is discovering new uses for biological diversity in ways that can relieve both human suffering and environmental destruction. Third, much of the diversity is being irreversibly lost through extinction caused by the destruction of natural habitats, again especially in the tropics. Overall, we are locked into a race. We must hurry to acquire the knowledge on which a wise policy of conservation and development can be based for centuries to come.

To summarize the problem in this chapter, I review some current information on the magnitude of global diversity and the rate at which we are losing it. I concentrate on the tropical moist forests, because of all the major habitats, they are richest in species and because they are in greatest danger.

THE AMOUNT OF BIOLOGICAL DIVERSITY

Many recently published sources, especially the multiauthor volume *Synopsis and Classification of Living Organisms*, indicate that about 1.4 million living species of all kinds of organisms have been described (Parker, 1982; see also the numerical breakdown according to major taxonomic category of the world insect fauna prepared by Arnett, 1985). Approximately 750,000 are insects, 41,000 are vertebrates, and 250,000 are plants (that is, vascular plants and bryophytes). The remainder consists of a complex array of invertebrates, fungi, algae, and microorganisms (see Table 1-1). Most systematists agree that this picture is still very incomplete except

TABLE 1-1 Numbers of Described Species of Living Organisms[a]

Kingdom and Major Subdivision	Common Name	No. of Described Species	Totals
Virus			
	Viruses	1,000 (order of magnitude only)	1,000
Monera			
Bacteria	Bacteria	3,000	
Myxoplasma	Bacteria	60	
Cyanophycota	Blue-green algae	1,700	4,760
Fungi			
Zygomycota	Zygomycete fungi	665	
Ascomycota (including 18,000 lichen fungi)	Cup fungi	28,650	
Basidiomycota	Basidiomycete fungi	16,000	
Oomycota	Water molds	580	
Chytridiomycota	Chytrids	575	
Acrasiomycota	Cellular slime molds	13	
Myxomycota	Plasmodial slime molds	500	46,983
Algae			
Chlorophyta	Green algae	7,000	
Phaeophyta	Brown algae	1,500	
Rhodophyta	Red algae	4,000	
Chrysophyta	Chrysophyte algae	12,500	
Pyrrophyta	Dinoflagellates	1,100	
Euglenophyta	Euglenoids	800	26,900
Plantae			
Bryophyta	Mosses, liverworts, hornworts	16,600	
Psilophyta	Psilopsids	9	
Lycopodiophyta	Lycophytes	1,275	
Equisetophyta	Horsetails	15	
Filicophyta	Ferns	10,000	
Gymnosperma	Gymnosperms	529	
Dicotolydonae	Dicots	170,000	
Monocotolydonae	Monocots	50,000	248,428
Protozoa			
	Protozoans: Sarcomastigophorans, ciliates, and smaller groups	30,800	30,800
Animalia			
Porifera	Sponges	5,000	
Cnidaria, Ctenophora	Jellyfish, corals, comb jellies	9,000	
Platyhelminthes	Flatworms	12,200	
Nematoda	Nematodes (roundworms)	12,000	
Annelida	Annelids (earthworms and relatives)	12,000	

TABLE 1-1 Continued

Kingdom and Major Subdivision	Common Name	No. of Described Species	Totals
Mollusca	Mollusks	50,000	
Echinodermata	Echinoderms (starfish and relatives)	6,100	
Arthropoda	Arthropods		
Insecta	Insects	751,000	
Other arthropods		123,161	
Minor invertebrate phyla		9,300	989,761
Chordata			
Tunicata	Tunicates	1,250	
Cephalochordata	Acorn worms	23	
Vertebrata	Vertebrates		
Agnatha	Lampreys and other jawless fishes	63	
Chrondrichthyes	Sharks and other cartilaginous fishes	843	
Osteichthyes	Bony fishes	18,150	
Amphibia	Amphibians	4,184	
Reptilia	Reptiles	6,300	
Aves	Birds	9,040	
Mammalia	Mammals	4,000	43,853
TOTAL, all organisms			1,392,485

[a]Compiled from multiple sources.

in a few well-studied groups such as the vertebrates and flowering plants. If insects, the most species-rich of all major groups, are included, I believe that the absolute number is likely to exceed 5 million. Recent intensive collections made by Terry L. Erwin and his associates in the canopy of the Peruvian Amazon rain forest have moved the plausible upper limit much higher. Previously unknown insects proved to be so numerous in these samples that when estimates of local diversity were extrapolated to include all rain forests in the world, a figure of 30 million species was obtained (Erwin, 1983). In an even earlier stage is research on the epiphytic plants, lichens, fungi, roundworms, mites, protozoans, bacteria, and other mostly small organisms that abound in the treetops. Other major habitats that remain poorly explored include the coral reefs, the floor of the deep sea, and the soil of tropical forests and savannas. Thus, remarkably, we do not know the true number of species on Earth, even to the nearest order of magnitude (Wilson, 1985a). My own guess, based on the described fauna and flora and many discussions with entomologists and other specialists, is that the absolute number falls somewhere between 5 and 30 million.

A brief word is needed on the meaning of species as a category of classification. In modern biology, species are regarded conceptually as a population or series of populations within which free gene flow occurs under natural conditions. This means that all the normal, physiologically competent individuals at a given time are capable of breeding with all the other individuals of the opposite sex belonging