

Center for Biodiversity and Conservation

Milstein Science Symposium

Exploring the Dynamic Relationship Between Health and the Environment

April 2 and 3, 2009



Exploring the Dynamic Relationship Between Health and the Environment is organized by the American Museum of Natural History's Center for Biodiversity and Conservation and its Sackler Institute for Comparative Genomics.

The Museum is deeply grateful for the exceptionally generous leadership support for this Center for Biodiversity and Conservation Milstein Science Symposium from the Paul and Irma Milstein Family.

Additional support is provided by a grant from the Defense Advanced Research Projects Agency (DARPA) of the United States Department of Defense, the Karen Katen Foundation, and the Mack Lipkin Man and Nature Series.

Symposium Content Coordinators:

Andrés Gómez
Nora Bynum
Eleanor J. Sterling
George Amato

Symposium Logistics Coordinator:

Fiona Brady

Symposium Supervisor:

Felicity Arengo

Technology Coordinators:

Tony Alexander
Ho-Ling Poon

Multimedia Content Developer:

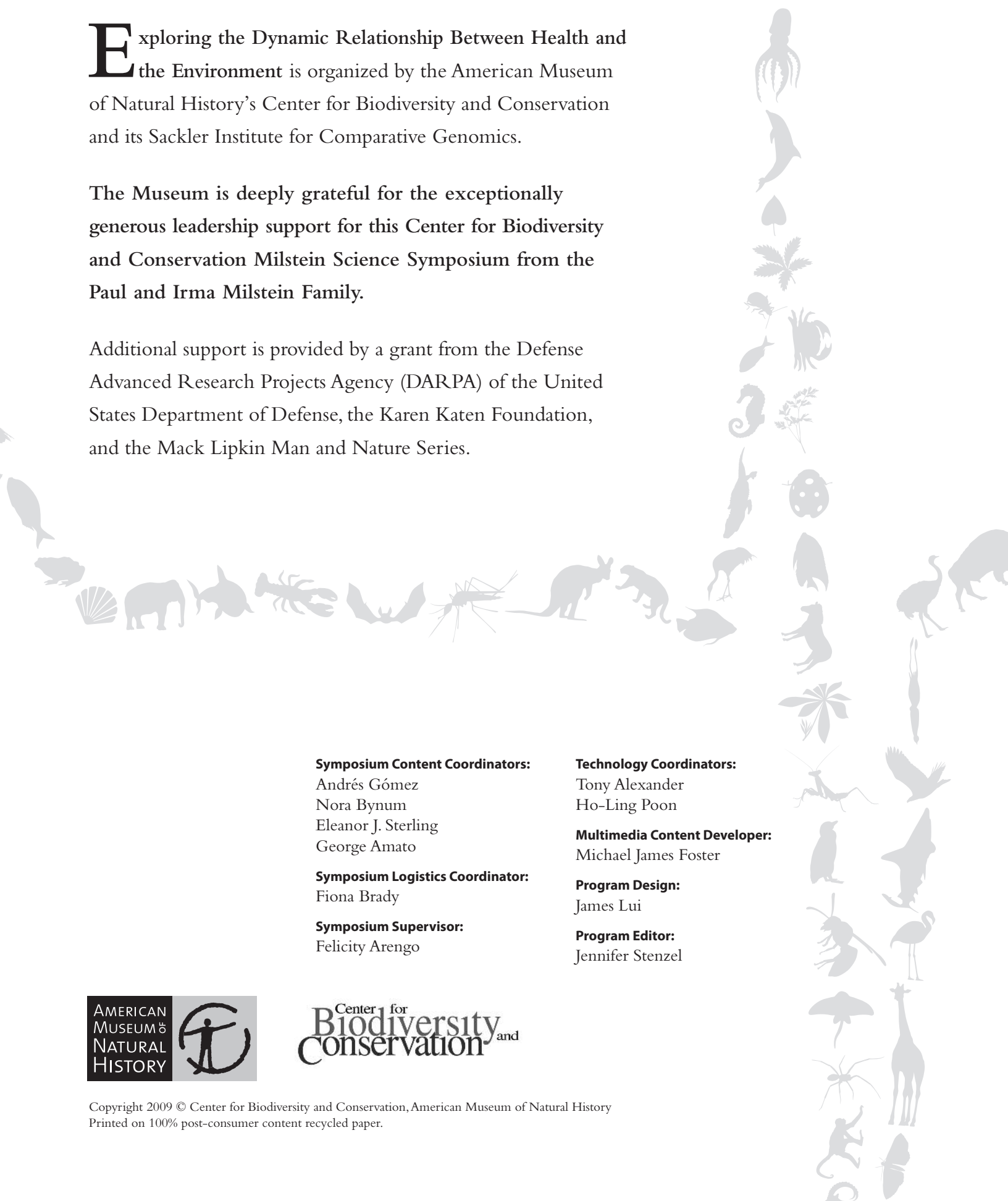
Michael James Foster

Program Design:

James Lui

Program Editor:

Jennifer Stenzel



The Center for Biodiversity
and Conservation
Milstein Science Symposium

Exploring the Dynamic Relationship Between Health and the Environment

April 2 and 3, 2009



That much of the dynamic equilibrium we call “health” depends on our interactions with our surroundings has been part of medical lore for centuries. In this current age of unprecedented environmental change, it is increasingly critical to understand the relationships among our own health, the health of all species with which we share the planet, and the ecosystems that ultimately support our survival. Human impacts such as ecosystem alteration, biodiversity loss, and diminished ecosystem services can result in disease emergence and spread as well as increases in the incidence or severity of non-communicable diseases, including asthma, allergies, and developmental disorders. Environmental conditions can even have an effect on our mental health and intellectual performance. However, as our understanding of the patterns and consequences of deteriorating environmental conditions increases, so does our capacity to predict, avoid, and mitigate negative influences on our health.

Understanding the environmental context of health is a prerequisite for designing sustainable policies that address our current environmental and public health needs. This requires a deeper scientific knowledge about several issues, including the nature of the environmental drivers of disease; the relationship between the health of humans and animals; the health-related goods and services we derive from biodiversity; and the nature, magnitude, and impact of costs resulting from policies enacted to benefit either health or the environment. Research about the environmental determinants of health has uncovered complex relationships that are dependent on processes occurring at varying spatial and temporal scales, that are frequently mediated by multiple interacting drivers, and that often require tools able to examine the very small (e.g. molecular mechanisms) alongside the extraordinarily large (e.g. global patterns of trade and travel). Ultimately, health cannot be viewed as independent from the environment, and in this framework, contributions from disciplines other than the biomedical sciences become vitally important. Health thus becomes the realm of ecologists, conservation and evolutionary biologists, climate scientists, architects, city planners, energy and transportation experts, and many others historically separated by academic tradition and the lack of common languages and fora for collaborative interaction.

In recent years, growing interest in these issues has resulted in significant progress toward building robust scientific protocols, alleviating key data gaps, and building strategic partnerships and alliances. This symposium aims to highlight progress made in science and policy of the environmental context of health. The variety of viewpoints included in this program represents a diverse cross-section of the expertise that informs this integrative inquiry and understanding. Beyond highlighting specific threats to our health and our environment, it is a call to action—a look at both the dangers and the promises of an increasingly interconnected world, a reminder that mutual benefits are both desirable and possible, and an invitation to advance our research linkages and enhance collaboration among disciplines.



EXPLORING THE DYNAMIC RELATIONSHIP
BETWEEN HEALTH AND THE ENVIRONMENT

THURSDAY, APRIL 2, 2009

7:30 Registration (77th Street Lobby)

8:30 **SESSION I** *Kaufmann Theater*

**Setting the Stage:
The Environmental Context of Health**

Moderator: **ELEANOR J. STERLING**, Director,
Center for Biodiversity and Conservation, American
Museum of Natural History, New York, New York, US

KEYNOTE PRESENTATION

Environmental Burden of Disease: Acting to
Reduce Current and Emerging Threats

CARLOS CORVALÁN, Senior Advisor, Sustainable
Development and Environmental Health, Pan American
Health Organization (PAHO), Regional Office for the
Americas of the World Health Organization (WHO),
Brasilia, Brazil

KEYNOTE PRESENTATION

The Environment and Human Health:
The Need to Paddle Upstream

HOWARD FRUMKIN, Director, National Center for
Environmental Health, Agency for Toxic Substances
and Disease Registry, Centers for Disease Control and
Prevention, Atlanta, Georgia, US

KEYNOTE PRESENTATION

Evidence-Based Policies for Global
Environmental Health Risks

MAJID EZZATI, Associate Professor of International
Health, Department of Global Health and Population,
Department of Environmental Health, Harvard School
of Public Health, Cambridge, Massachusetts, US

KEYNOTE PRESENTATION

Health and the Environment in
the Age of Genomics

JANE CARLTON, Director of Genomics and Associate
Professor of Medical Parasitology, New York University
Langone Medical Center, New York, New York, US

REMARKS

ELLEN V. FUTTER, President, American Museum
of Natural History, New York, New York, US

HOWARD P. MILSTEIN, Chair, President and
CEO, New York Private Bank & Trust, New York, New
York, US

10:45 Coffee Break (*Northwest Coast Indians*)

11:15 **SESSION II** *Kaufmann Theater*

**Understanding Complexity:
Multiple and Interacting Stressors**

Moderator: **FELICITY ARENGO**, Associate
Director, Center for Biodiversity and Conservation,
American Museum of Natural History, New York,
New York, US

Climate Impacts on Indigenous People's
Health and Well-Being

DONNA GREEN, Faculty of Science, Climate
Change Research Centre, University of New South
Wales, Sydney, Australia

Globalisation and Human Health:
Sustainable Health in a Changing World

PIM MARTENS, Director, International Centre for
Integrated Assessment and Sustainable Develop-
ment, Maastricht University, The Netherlands

Human Health Impacts of Climate
Change: Insights from the Wild

CAMILLE PARMESAN, Associate Professor,
Section of Integrative Biology, University of Texas at
Austin, Austin, Texas, US

12:30 Lunch Break (*Milstein Hall of Ocean Life*)

A Balancing Act: Decision Making, Trade-Offs, and Mutual Benefits for Health and the Environment

Moderator: **SUSAN PERKINS**, Assistant Curator, Invertebrate Zoology and Sackler Institute for Comparative Genomics, American Museum of Natural History, New York, New York, US

KEYNOTE PRESENTATION

Biodiversity, Climate Change, and Health

ANDREW P. DOBSON, Professor, Department of Ecology and Evolutionary Biology, Princeton University, Princeton, New Jersey, US

Ethnomedical Systems, Biodiversity, and Primary Health Care in Micronesia

MICHAEL J. BALICK, Vice President for Botanical Science, Director and Philecology Curator, Institute of Economic Botany, New York Botanical Garden, Bronx, New York, US

Air Pollution, Climate Change, and Human Health: Impacts and Opportunities

PATRICK L. KINNEY, Associate Professor, Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, New York, US

Biodiversity for Nutrition and Health: Reversing the Simplification of Diets and Ecosystems

PABLO B. EYZAGUIRRE, Senior Scientist, Anthropology and Socioeconomics, Bioversity International, Rome, Italy

On Prioritizing Risk-Reducing Strategies in a Dynamic Environment

GARY W. YOHE, Woodhouse/Sysco Professor of Economics, Wesleyan University, Middletown, Connecticut, and Visiting Professor of Economics, Yale School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut, US

4:00 Coffee Break (*Northwest Coast Indians*)

4:30 **PANEL DISCUSSION** (*Kaufmann Theater*)

Decision Making, Trade-Offs, and Mutual Benefits

Moderator: **NORA BYNUM**, Project Director, Network of Conservation Educators and Practitioners (NCEP), and Associate Director for Capacity Development, Center for Biodiversity and Conservation, American Museum of Natural History, New York, New York, US

LORA FLEMING, Professor, Departments of Epidemiology and Public Health, and Marine Biology and Fisheries, Miller School of Medicine and Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida, US

PIM MARTENS, Director, International Centre for Integrated Assessment and Sustainable Development, Maastricht University, The Netherlands

KENT H. REDFORD, Director, Wildlife Conservation Society Institute, and Vice President, Conservation Strategy, Wildlife Conservation Society, Bronx, New York, US

WILLIAM C. SULLIVAN, Professor, Landscape Architecture, and Director, Environmental Council, University of Illinois at Urbana-Champaign, Urbana, Illinois, US

5:15 – 7:00

Milstein Hall of Ocean Life

2009 MACK LIPKIN MAN AND NATURE SERIES POSTER SESSION AND RECEPTION

7:00 – 8:30

LeFrak Theater

2009 MACK LIPKIN MAN AND NATURE SERIES PANEL DISCUSSION

It Takes a Planet: Connecting the Health of People and Nature

Introduction: **MICHAEL J. NOVACEK**, Senior Vice President and Provost of Science, American Museum of Natural History, New York, New York, US

Moderator: **JULIE BURSTEIN**, Executive Producer, "Studio 360," Public Radio International and WNYC Radio, New York, New York, US

PETER DASZAK, President, Wildlife Trust, and Executive Director, Consortium for Conservation Medicine, New York, New York, US

PEGGY M. SHEPARD, Executive Director, West Harlem Environmental Action, Inc. (WE ACT), New York, New York, US

WALTER MUGDAN, Director, Emergency and Remedial Response Division, U. S. Environmental Protection Agency, Region 2, New York, New York, US

The Mack Lipkin Man and Nature Series was established in honor of Dr. Mack Lipkin, Sr., by his many friends and admirers. Dr. Lipkin was a physician who was a gentle and powerful force towards advancing the most humane and caring practices of medicine. The Museum is proud to welcome Peggy Shepard, Peter Daszak, and Walter Mugdan as the 2009 Mack Lipkin Man and Nature Series Fellows.

EXPLORING THE DYNAMIC RELATIONSHIP
BETWEEN HEALTH AND THE ENVIRONMENT

FRIDAY, APRIL 3, 2009

9:00 SESSION IV Kaufmann Theater

Pathogens and Evolution

Moderator: **GEORGE AMATO**, Director, Sackler Institute for Comparative Genomics, American Museum of Natural History, New York, New York, US

Expecting the Unexpected in Disease Emergence

PETER J. HUDSON, Director, Huck Institutes of the Life Sciences, and Willaman Chair of Biology, Center for Infectious Disease Dynamics, Pennsylvania State University, University Park, Pennsylvania, US

Ecology and Molecular Epidemiology of Human-Primate Disease Transmission in Western Uganda

TONY L. GOLDBERG, Professor, Epidemiology, Department of Pathobiological Sciences, School of Veterinary Medicine, University of Wisconsin-Madison, Madison, Wisconsin, US

Phylogenetics: Integrating the Evolutionary and Ecological Dynamics of Infectious Disease

OLIVER G. PYBUS, Royal Society University Research Fellow, University Lecturer (elect), Evolutionary Biology, Department of Zoology, University of Oxford, Oxford, UK

10:15 Coffee Break (*Northwest Coast Indians*)

10:50 Genomic and Metagenomic Approaches to the Study of Pathogen Genomes and Their Evolution

KAREN E. NELSON, Director, Human Microbiology and Metagenomics, Department of Human Genomic Medicine, The J. Craig Venter Institute, Rockville, Maryland, US

Helicobacter pylori, a Resident of the Human Gastric Micro-Environment that Both Causes and Protects Against Disease

MARTIN J. BLASER, Frederick H. King Professor of Internal Medicine, Chair, Department of Medicine, and Professor, Microbiology, New York University Langone Medical Center, New York, New York, US

11:35 PANEL DISCUSSION

Pathogens and Evolution

MARTIN J. BLASER, Frederick H. King Professor of Internal Medicine, Chair, Department of Medicine, and Professor, Microbiology, New York University Langone Medical Center, New York, New York, US

ROB DeSALLE, Curator, Division of Invertebrate Zoology, American Museum of Natural History, New York, New York, US

TONY L. GOLDBERG, Professor, Epidemiology, Department of Pathobiological Sciences, School of Veterinary Medicine, University of Wisconsin-Madison, Madison, Wisconsin, US

KAREN E. NELSON, Director, Human Microbiology and Metagenomics, Department of Human Genomic Medicine, The J. Craig Venter Institute, Rockville, Maryland, US

OLIVER G. PYBUS, Royal Society University Research Fellow, University Lecturer (elect), Evolutionary Biology, Department of Zoology, University of Oxford, Oxford, UK

12:30 Lunch Break (*Milstein Hall of Ocean Life*)

2:00 SESSION V

Kaufmann Theater

Looking Ahead: Data Gaps and Research Needs

Moderator: **ANDRÉS GÓMEZ**, Postdoctoral Fellow, Center for Biodiversity and Conservation, American Museum of Natural History, New York, New York, US

2:00 PANEL DISCUSSION

CARLOS CORVALÁN, Senior Advisor, Sustainable Development and Environmental Health, Pan American Health Organization (PAHO), Regional Office for the Americas of the World Health Organization (WHO), Brasilia, Brazil

PABLO B. EYZAGUIRRE, Senior Scientist, Anthropology and Socioeconomics, Bioversity International, Rome, Italy

MARC A. LEVY, Deputy Director and Associate Director for Science Applications, Center for International Earth Science Information Network (CIESIN), Columbia University, New York, New York, US

CAMILLE PARMESAN, Associate Professor, Section of Integrative Biology, University of Texas at Austin, Austin, Texas, US

2:50 Understanding the Links Between Human Health and the Oceans

LORA FLEMING, Professor, Departments of Epidemiology and Public Health, and Marine Biology and Fisheries, Miller School of Medicine and Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida, US

3:15 Coffee Break (*Northwest Coast Indians*)

3:45 SESSION VI

Kaufmann Theater

The Way Forward: Partnerships, Alliances, and Innovation

Forging New Connections among Environmental Health Scholars

WILLIAM C. SULLIVAN, Professor, Landscape Architecture, and Director, Environmental Council, University of Illinois at Urbana-Champaign, Urbana, Illinois, US

4:15 PANEL DISCUSSION

The Way Forward: Partnerships, Alliances, and Innovation

Moderator: **THOMAS E. LOVEJOY**, Biodiversity Chair, The H. John Heinz III Center for Science, Economics and the Environment, Washington, DC, US

JEFFREY M. BLANDER, Co-leader, Technology Innovation Working Group, Harvard Initiative for Global Health, Cambridge, Massachusetts, US

DONNA GREEN, Faculty of Science, Climate Change Research Centre, University of New South Wales, Sydney, Australia

AMY LUERS, Program Manager, Environment and Vulnerability Mapping, Predict and Prevent, Google.org, Mountain View, California, US

JONATHAN PATZ, Professor, Environmental Studies and Population Health Sciences, and Director, Center for Sustainability and the Global Environment, University of Wisconsin-Madison, Madison, Wisconsin, US

CLOSING REMARKS

5:15 Conference Adjourns

Michael J. Balick

Vice President for Botanical Science, Director and Philecology Curator, Institute of Economic Botany, New York Botanical Garden, Bronx, New York, US

Ethnomedical Systems, Biodiversity, and Primary Health Care in Micronesia

Micronesia is a remote part of the world, with a rich ethnomedical tradition and, in many areas, high levels of plant endemism. Island peoples are particularly skilled at discovering and developing technologies for plant utilization, as their resource base is limited by the island's size and degree of isolation. Micronesian peoples have used plants for many purposes, including provision of primary health care. Since 1997, a research team of local and international researchers—biologists, physicians, traditional healers, conservationists, and specialists in local culture—has been conducting biodiversity and ethnomedical surveys on the islands of Pohnpei and Kosrae in the Federated States of Micronesia and The Republic of Palau. One focus of the program is to inventory the medicinal plants of the region, collecting data on diversity and abundance of species and their uses. We have recently published a book on Pohnpei Island, which details medical uses, dosages, and formulations for 206 species of plants found there, an astonishing 21% of the total flora. Concurrently, we are working on a primary health care manual that incorporates an evidence-based approach to using local plants in health care. The model developed by this program is to incorporate sustainable plant resources and ethnomedical modalities into the state run systems of village dispensaries, clinics, and the hospital. As village dispensaries on many Pacific islands lack prescription pharmaceuticals, traditional medical systems and the plants they use can play an important role in improving health care. With a greater awareness of the importance of local resources in contemporary life comes the realization that these modalities must be managed in a sustainable way, particularly on small islands. Thus, it is clear that improving primary health care depends on maintaining a diverse environment, and biological conservation is now attracting a new and influential constituency—the local physicians in the region.

Martin J. Blaser

Frederick H. King Professor of Internal Medicine, Chair, Department of Medicine, and Professor, Microbiology, New York University Langone Medical Center, New York, New York, US

***Helicobacter pylori*, a Resident of the Human Gastric Micro-Environment that Both Causes and Protects Against Disease**

H*elicobacter pylori* is an ancient bacterial member of the human gastric micro-environment. *H. pylori* populations are highly dynamic and interactive with the gastric epithelium. The net interchange affects both local and systemic human physiology. As a result of modern lifestyles, *H. pylori* is disappearing from human populations, and becoming extinct; as such, it now is clear that *H. pylori* status affects both physiology and disease risk. *H. pylori* positivity increases risk for both ulcer disease and gastric cancer. With its decline, diseases of the esophagus related to gastroesophageal reflux disease (GERD) and its consequences, including adenocarcinoma of the esophagus, are becoming more frequent, and an extensive body of evidence links these reciprocal events. Similar observations have been made recently about childhood asthma and related disorders. The ways in which *H. pylori* might protect against disease involve hormonal and chemical regulation, immunologic mechanisms, and/or effects on other residential microbiota. Using the example of *H. pylori*, secular changes in our micro-environment mimic changes in our macro-environment (e.g., global warming) with unanticipated consequences.

Jane Carlton

Director of Genomics and Associate Professor of Medical Parasitology, New York University Langone Medical Center, New York, NY, US

Keynote Presentation:

Health and the Environment in the Age of Genomics

Genomics—the study of genomes of living organisms—is an immensely powerful discipline that is being harnessed to examine interactions between human health and the environment. The genomes of thousands of parasites, bacteria, and viruses that cause serious human diseases have been decoded, as have genomes of animals, fungi, and plants, providing insights into evolution, new drug and vaccine targets, and novel methods of disease surveillance. Examples of genome projects will be given, including the Human Microbiome Project, which aims to sequence the DNA of all the microbes found in bodily micro-environments, and environmental genomics projects that are cataloguing microbial diversity.

Carlos Corvalán

Senior Advisor, Sustainable Development and Environmental Health, Pan American Health Organization (PAHO), Regional Office for the Americas of the World Health Organization (WHO), Brasilia, Brazil

Keynote Presentation:

Environmental Burden of Disease: Acting to Reduce Current and Emerging Threats

The World Health Organization (WHO) has estimated that around one quarter of the global burden of disease could be reduced through existing environmental interventions. This fraction is higher in poor countries and among children. In spite of action in many countries to address current environmental health problems and their inherent inequalities, emerging issues such as ecosystem degradation, depletion of water resources, changes in land use and climate change in particular, are threatening these advances. Recent interest to implement a global agenda for climate change and health is an opportunity to address simultaneously current and emerging issues, and build an integrated agenda for action.

Andrew P. Dobson

Professor, Department of Ecology and Evolutionary Biology, Princeton University, Princeton, New Jersey, US

Keynote Presentation:

Biodiversity, Climate Change, and Health

Human health and the health of all the non-voting species is intimately linked to climate and the surrounding environment. In this talk I will give a number of examples of how changes in the environment interact with climate change to create changes in the health of humans, “animal” and plant populations, and communities. Understanding the dynamics and impact of these problems requires a significant increase in interactions between ecologists, epidemiologists, and economists. Genomics may also be useful for many post-hoc analyses, but it will never allow us to develop a predictive framework needed to understand the interactions between health, climate, and the environment at the spatial and temporal scales where we need to develop effective management and intervention strategies. So a redistribution of funding priorities is desperately needed if we are to understand this important class of environmental problems.

Pablo B. Eyzaguirre

Senior Scientist, Anthropology and Socioeconomics, Bioversity International, Rome, Italy

COAUTHORS:

T.Johns and **I.F. Smith**

Bioversity International

Biodiversity for Nutrition and Health: Reversing the Simplification of Diets and Ecosystems

Human health is based on adequate supply of foods containing the energy, nutrients, and functional properties that are essential for good health. Humans have met these fundamental needs through the consumption of a diverse range of plant and animal foods available in a wide range of ecosystems. Dietary diversity has been the basis of good nutrition and health across food cultures by using the food resources available in local ecosystems including agro-ecosystems. Using examples from the ecologies and food systems of West Africa, East Africa, South and Southeast Asia, and South America, the paper describes the range of foods sourced from local biodiversity that are being eroded as ecosystems are simplified and biodiversity is reduced or lost. The concomitant global trends to simplify diets and food systems along with the simplification and erosion of ecosystems have focused attention on the link between biodiversity, dietary diversity, and human health. From the perspective of human health, food-based approaches to improved nutrition depend on the maintenance of dietary diversity. However, such a strategy is at risk as many of the world's ecosystems that provide foods with important nutritional value and health properties are increasingly threatened and diminished. The link between biodiversity as the basis of good nutrition and health may provide a strong incentive and clear rationale to maintain diversity in local ecosystems as it underpins healthy diets and food cultures. Some examples are given of how biodiversity can be sustainably used to address global health problems arising from simplified, high-energy modern diets.

Majid Ezzati

Associate Professor of International Health, Department of Global Health and Population, Department of Environmental Health, Harvard School of Public Health, Cambridge, Massachusetts, US

Keynote Presentation:

Evidence-Based Policies for Global Environmental Health Risks

Despite the wide awareness of the important role of the environment as a determinant of the population health, there are substantially fewer systematic analyses of which environmental policies and technologies can provide large and equitable improvements in population health. This presentation will use examples of global, national, and sub-national analyses of environmental risk factors and interventions to demonstrate a systematic approach to developing scientific evidence for priority setting and policy implementation.

Lora Fleming

Professor, Departments of Epidemiology and Public Health, and Marine Biology and Fisheries, Miller School of Medicine and Rosenstiel School of Marine and Atmospheric Sciences, Miami, Florida, US

Understanding the Links Between Human Health and the Oceans

Recent evidence shows that there are important links between human health and the oceans. These interlinking issues include: global climate change, extreme weather, anthropogenic pollution of food chains, harmful algal blooms (HABs), microbial pollution of recreational marine waters, seafood safety, sensors and integrated ocean observing systems, policy and ethics, and natural products from the seas. This has led to the development of a new interdisciplinary scientific discipline of oceans and human health. The four National Science Foundation (NSF) National Institute of

Environmental Health Sciences (NIEHS) and three National Oceanographic and Atmospheric Administration (NOAA) Oceans and Human Health Centers were established five years ago to promote interdisciplinary research, education, training, and outreach in oceans and human health at the interface between the biomedical and oceanographic sciences. Oceanographic and biomedical researchers work in teams to perceive and explore these issues in new ways across scientific disciplines. Students of all levels participate in these research teams, which actively demonstrate the importance and the logistics of interdisciplinary approaches. In addition, NOAA OHH Traineeships, NSF research experience for undergraduates (REU), new courses, and a textbook on Oceans and Human Health have attracted students from many different disciplines. As a culminating experience for researchers and students, a new Gordon Research Conference and Graduate Research Seminar on Oceans and Human Health have served to bring together researchers and students from diverse scientific disciplines ranging from microbiology and epidemiology to anthropology and engineering to oceanography and toxicology.

Howard Frumkin

Director, National Center for Environmental Health, Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention, Atlanta, Georgia, US

Keynote Presentation:

The Environment and Human Health: The Need to Paddle Upstream

The links between environment and health have been recognized since the beginning of history. The places in which we live, work and play, the water we drink, the air we breathe, and the food we eat, all have impacts on health. In an increasingly complex world, other factors also play a role: the ways we design our communities, the ways we travel, the sources of energy we utilize, the ways we conserve land. This talk provides an overview of the dynamic relationship between health and the environment by focusing on these “upstream” forces, and suggests how the health professions can link with other fields to advance science and health protection.

Tony L. Goldberg

Professor, Epidemiology, Department of Pathobiological Sciences, School of Veterinary Medicine, University of Wisconsin-Madison, Madison, Wisconsin, US

Ecology and Molecular Epidemiology of Human-Primate Disease Transmission in Western Uganda

Infectious diseases transmitted between humans and non-human primates pose a serious threat to human health, animal health, and primate conservation. By adopting a combined molecular and ecological approach, the Kibale EcoHealth Project endeavors to understand how human behavior, primate behavior, and land use patterns alter infectious disease transmission among primates, people, and domestic animals in and near Kibale National Park, Uganda. Molecular epidemiological analyses of bacterial and protozoan pathogens indicate that anthropogenic disturbance to primate habitats and ensuing ecological overlap between people and primates is the primary force driving interspecific transmission of gastrointestinal pathogens in this system. Specifically, genetic similarity between populations of *E. coli* bacteria and the protozoan parasite *Giardia duodenalis* from people and primates are highest in the most disturbed habitats and decline with decreasing intensities of habitat disturbance. Human health and human behavior modify these effects, with factors such as experiencing gastrointestinal symptoms and tending livestock being associated with elevated genetic similarity

between human and primate bacterial populations. Human-to-primate transmission is also enhanced by forest fragmentation and close interaction among species, due to such factors as research and tourism, as evidenced by molecular analyses of antibiotic-resistant bacteria in wild primates in such areas. For example, the prevalence of antibiotic resistant bacteria in populations of endangered mountain gorillas in Bwindi-Impenetrable National Park, Uganda, declines among populations with decreasing ecological overlap between humans and apes. Serologic and molecular studies indicate that primates in this region have been exposed to previously uncharacterized poxviruses and retroviruses, raising both conservation and public health concerns. Using molecular tools to identify specific links between habitat disturbance and human-wildlife pathogen exchange will facilitate targeted interventions that should lead to improved conservation planning and public health.

Donna Green

Faculty of Science, Climate Change Research Centre, University of New South Wales, Sydney, Australia

Climate Impacts on Indigenous People's Health and Well-Being

Indigenous people are incredibly resilient. For millennia, indigenous people have lived in a wide range of ecosystems across the world, gradually adapting to a naturally changing climate. In the last couple of hundred years, however, many remote indigenous communities have struggled to keep up with changes to their way of life brought by colonisation, industrialisation, and globalisation. The outcome for many communities has been devastating. Not only do many of these communities have some of the lowest socio-economic indicators in their respective countries, these changes have affected their physical and psychological health. Unfortunately, unless bold actions are taken to mitigate climate change and prepare culturally appropriate adaptive strategies, it is likely that the direct and indirect impacts of climate change will further negatively impact their culture and ability to live on their land. Indigenous Australians living in remote communities in the north and central regions of the country are likely to be disproportionately disadvantaged by the adverse impacts of climate change. Their vulnerability is heightened due to at least three factors: existing non-climate stresses, a culture that does not necessarily differentiate between natural and human systems in relation to the concept of "health," and a connection between the community's well-being and that of their country.

Peter J. Hudson

Director, Huck Institutes of the Life Sciences, and Willaman Chair of Biology, Center for Infectious Disease Dynamics, Pennsylvania State University, University Park, Pennsylvania, US

Expecting the Unexpected in Disease Emergence

Can we predict the emergence of novel infectious diseases? Where do they come from? Why do they become virulent? And what leads to their emergence? The simple answer is that we simply don't know because these are rare events and the data are lacking. There again greater insight could be obtained if we look at the variation between individuals, and seek to identify the functional groups or individuals responsible for transmission and some of the mechanisms responsible for making an individual highly infectious.

Patrick L. Kinney

Associate Professor, Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, New York, US

Air Pollution, Climate Change, and Human Health: Impacts and Opportunities

Fossil fuel combustion is responsible for the bulk of anthropogenic climate change, as well as for a substantial global burden of disease and premature mortality due to direct health effects of air pollutants like fine particles and ozone. Furthermore, these pollutants play a variety of roles in climate forcing and are in turn influenced by climate via changes in pollutant dispersion, transport, and atmospheric reactions. Because of these complex feedbacks, policies aimed at climate mitigation will affect air quality and visa versa. This talk will examine the current evidence for these interactions, and will illustrate an approach for integrated assessment of climate mitigation and human health.

Pim Martens

Director, International Centre for Integrated Assessment and Sustainable Development, Maastricht University, The Netherlands

Globalisation and Human Health: Sustainable Health in a Changing World

From a public health perspective, globalisation appears to be a mixed blessing. On the one hand, accelerated economic growth and technological advances have enhanced health and life expectancy in many populations. At least in the short-to-medium term, material advances allied to social modernisation and various health-care and public health programmes yield gains in overall population health. On the other hand, many aspects of globalisation are jeopardising population health via, amongst others, the erosion of social and environmental conditions, the global division of labour, and the exacerbation of the rich-poor gap between and within countries, as well as the accelerating spread of consumerism. A major manifestation of the increasing scale of the human enterprise is the advent of global environmental changes. The health of a population, if it is to be maintained in a “sustainable state,” requires the continued support of clean air, safe water, adequate food, tolerable temperature, stable climate, protection from solar ultraviolet (UV) radiation, and high levels of biodiversity. The processes of social-economic change, demographic change, and global environmental change in today’s world oblige us to broaden our conception of the determinants of population health. We must be increasingly alert to the influences on population health that arise from today’s larger-scale social-economic processes and systemic environmental disturbances. We will present a framework to conceptualise the health risk of global (environmental) changes and will present future developments according to a set of scenarios.

Karen E. Nelson

Director, Human Microbiology and Metagenomics, Department of Human Genomic Medicine, The J. Craig Venter Institute, Rockville, Maryland, US

Genomic and Metagenomic Approaches to the Study of Pathogen Genomes and Their Evolution

In the mid 1990s the real launch of the genomic era began with the availability of the complete genome sequence of *Haemophilus influenzae*. Since that major success, there have been numerous examples of genomes from organisms that represent all the domains of life, including the completion of hundreds of microbial genomes that represent both pathogenic and non-pathogenic species (hundreds of partial genomes are also available). The genomes have given tremendous insight into microbial evolution, lateral gene transfer, and approaches that microbes use to adapt to new niches. This sequencing

work also laid the foundation for generating genome sequence information from whole environments without using a first culturing step, a field of research now known as “metagenomics,” and the study of the human microbiome is now a major worldwide initiative. The evolution and adaptations of pathogenic species as we continue to learn from genomic and metagenomic studies will be presented.

Camille Parmesan

Associate Professor, Section of Integrative Biology, University of Texas at Austin, Austin, Texas, US

Human Health Impacts of Climate Change: Insights from the Wild

The World Health Organization has concluded that human-driven climate change has already affected human health. While some consensus has developed about future direct effects of climate change (e.g. impacts of increasing floods, more heat waves, and fewer cold snaps), there is much less consensus on how more complex impacts, such as disease incidence or food quality and availability, may develop. Part of the difficulty in developing projections for disease impacts is that data is skewed towards incidence of disease in human populations, rather than the ecology of diseases and their vectors in the wild. However, 66% of human pathogens also use wild animals as hosts. Poleward range shifts of up to 2000km, and upward range shifts of up to 400m, have been detected in meta-analyses of hundreds of insects, birds, and mammals over the past 30 to 130 years. Many species in each of these groups act as reservoirs or vectors of human diseases. It is likely, then, that climate change has already had a significant effect on the geographical range of many vector species and associated pathogens. Substantial evidence already exists that many vector-borne diseases are sensitive to climate variations. However, differences in disease incidence in climatically similar regions make it clear that models which consider climate alone without incorporating societal aspects of disease growth and transmission are likely to over-estimate disease expansion with climate change. Conversely, the rate of climate change is expected to increase rapidly in coming decades, which might lead to an underestimation of health impacts. Careful consideration should, therefore, be given to maximizing the chances of detecting early effects of climatic changes on disease distributions and dynamics in the wild, as well as on incidences in human populations. More subtle effects of climate change are also possible. Local food resources may be impacted in multiple ways by increased atmospheric carbon dioxide and associated climatic and sea level changes. Both subsistence and commercial fish populations may be reduced by loss of coastal nursery grounds due to rising sea level and by loss of tropical coral reefs. Terrestrial crops may be impacted by more than geographic shifts of growing regions. For example, studies of insect/plant interactions indicate a lowering of nutritional value of plants grown in a high CO₂ environment sufficient to significantly impact insect growth, with obvious implications for human crops.

Oliver G. Pybus

Royal Society University Research Fellow, University Lecturer (elect), Evolutionary Biology, Department of Zoology, University of Oxford, Oxford, UK

Phylodynamics: Integrating the Evolutionary and Ecological Dynamics of Infectious Disease

Many micro-organisms, particularly RNA viruses, evolve so quickly that their evolutionary and epidemiological dynamics occur on a similar timescale and interact in complex ways. Understanding and measuring this relationship is the key goal

of the new field of phylodynamics, which combines ideas from phylogenetics, ecology, population genetics, and immunology. Evolutionary and epidemiological processes are typically combined by placing them on a common timescale or spatial frame of reference, an approach that can be applied at hugely different biological scales, from studies of global pandemics to investigations of pathogen evolution within a single organism. I hope to explain and illustrate the range of empirical questions open to phylodynamic analysis, with an inevitable bias toward RNA viral infections of humans.

William C. Sullivan

Professor, Landscape Architecture,
and Director, Environmental
Council, University of Illinois at
Urbana-Champaign, Urbana,
Illinois, US

Forging New Connections among Environmental Health Scholars

There is wide recognition that the environments in which we live, work, and play impact human health both positively and negatively. In spite of this recognition, however, there are few opportunities for scholars from Medicine, Public Health, Environmental Design, and the Environmental Sciences to collaborate while teaching about the environmental health challenges of this new millennium. A unique partnership is working to address this paucity of interaction among environmental health scholars. Our collaboration involves the National Institute of Medicine's Roundtable on Environmental Health Sciences, Research, and Medicine, the Centers for Disease Control and Prevention, and the Council of Environmental Deans and Directors. Our purpose is to engage scholars from a variety of disciplines, prepare instructional materials (e.g., case studies, exercises, lectures), and develop a learning community of scholars who will interact with each other and share resources. This talk considers our progress to date, and invites your participation as we move forward.

Gary W. Yohe

Woodhouse/Sysco Professor of
Economics, Wesleyan University,
Middletown, Connecticut, and
Visiting Professor of Economics, Yale
School of Forestry and Environmental
Studies, Yale University, New Haven,
Connecticut, US

On Prioritizing Risk-Reducing Strategies in a Dynamic Environment

Risk-based analyses of how humans might respond to dynamic sources of external stresses by reducing exposure (through mitigation) and/or sensitivity (through adaptation) have become increasingly popular. Based on first principles of economic efficiency, these analyses explain why people buy insurance, diversify their portfolios and, perhaps most generally, try as hard as they can to "hedge their bets" in confronting uncertain futures by adopting robust strategies. This presentation will demonstrate how the statistical definition of risk can prioritize alternative responses across sectors, space, and time, even with limited information, and thereby identify cost effective collections of robust strategies when resources are tight and information is sparse. It will build on a decision-support tool derived by the New York Panel on Climate Change to characterize climate-related vulnerabilities to critical infrastructure. The template was designed to illuminate critical tradeoffs across a wide range of possible responses and across multiple vulnerabilities that all make claims on the same resource base. While climate change was the motivation for its creation, it can also be applied to environmental and health risks derived from any external source of dynamic stress. Of course, as we have learned from the recent financial meltdown, it is important to emphasize reducing risk cannot guarantee that catastrophic consequences will be avoided.

George Amato

Director, Sackler Institute for Comparative Genomics, American Museum of Natural History, New York, New York, US

Felicity Arengo

Associate Director, Center for Biodiversity and Conservation, American Museum of Natural History, New York, New York, US

Andrew Balmford

Professor of Conservation Science, Department of Zoology, University of Cambridge, Cambridge, UK

Nora Bynum

(symposium content coordinator)
Project Director, Network of Conservation Educators and Practitioners (NCEP), and Associate Director for Capacity Development, Center for Biodiversity and Conservation, American Museum of Natural History, New York, New York, US

Carlos Corvalán

Senior Advisor, Sustainable Development and Environmental Health, Pan American Health Organization (PAHO), Regional Office for the Americas of the World Health Organization (WHO), Brasilia, Brazil

Andrew P. Dobson

Professor, Department of Ecology and Evolutionary Biology, Princeton University Princeton, New Jersey, US

Howard Frumkin

Director, National Center for Environmental Health, Agency for Toxic Substances and Disease Registry, U.S. Centers for Disease, Control and Prevention, Atlanta, Georgia, US

Andrés Gómez

(symposium content coordinator)
Postdoctoral Fellow, Center for Biodiversity and Conservation, American Museum of Natural History, New York, New York, US

Donna Green

Faculty of Science, Climate Change Research Centre, University of New South Wales, Sydney, Australia

C. Drew Harvell

Professor, Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, New York, US

Ursula King

Climate Change Research Centre, University of New South Wales, Sydney, Australia

Patrick L. Kinney

Associate Professor, Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, New York, US

Sergios-Orestis Kolokotronis

Research Coordinator and DARPA Postdoctoral Fellow, Sackler Institute for Comparative Genomics, American Museum of Natural History, New York, New York, US

Marc A. Levy

Deputy Director and Associate Director for Science Applications, Center for International Earth Science Information Network (CIESIN), Columbia University, New York, New York, US

Thomas E. Lovejoy

Biodiversity Chair, The H. John Heinz III Center for Science, Economics and the Environment, Washington, DC, US

Pim Martens

Director, International Centre for Integrated Assessment and Sustainable Development, Maastricht University, The Netherlands

Camille Parmesan

Associate Professor, Section of Integrative Biology, University of Texas at Austin, Austin, Texas, US

Jonathan Patz

Professor, Environmental Studies and Population Health Sciences, and Director, Center for Sustainability and the Global Environment, University of Wisconsin-Madison, Madison, Wisconsin, US

Cristián Samper

Director, National Museum of Natural History, Smithsonian Institution, Washington, DC, US

Neil W. Schluger

Chief, Division of Pulmonary, Allergy, and Critical Care Medicine, Professor of Medicine, Epidemiology, and Environmental Health Sciences, Columbia University College of Physicians and Surgeons, New York, New York, US

Eleanor J. Sterling

Director, Center for Biodiversity and Conservation, American Museum of Natural History, New York, New York, US

Michael Foster

Center for Biodiversity and Conservation, American Museum of Natural History

Gretchen Loeffler Peltier

The Earth Institute, Columbia University

Kevin Olival

Sackler Institute for Comparative Genomics, American Museum of Natural History

Susan Perkins

Invertebrate Zoology and Sackler Institute for Comparative Genomics, American Museum of Natural History

Jennifer Stenzel

Center for Biodiversity and Conservation, American Museum of Natural History

Gerardo Suzán

Veterinary School, National Autonomous University of Mexico

Many others contributed to the planning and execution of this symposium and, while they are far too numerous to list individually, the Center for Biodiversity and Conservation extends its thanks to all of them.

OFFICERS

Lewis W. Bernard
Chairman

Ellen V. Futter
President

Nancy B. Fessenden
Secretary

Charles H. Mott
Treasurer

Roger C. Altman
Vice Chairman

Steven A. Denning
Vice Chairman

Fiona Druckenmiller
Vice Chairman

Louis V. Gerstner, Jr.
Vice Chairman

David S. Gottesman
Vice Chairman

Frederick A. Klingenstein
Vice Chairman

Edwin H. Morgens
Vice Chairman

TRUSTEES

Roger C. Altman

Stephanie Bell-Rose

Lewis W. Bernard

Tom Brokaw

Dorothy Cullman

Christopher C. Davis

Steven A. Denning

Vivian H. Donnelley

Fiona Druckenmiller

John L. Eastman

Nancy B. Fessenden

Tom Freston

Ellen V. Futter

Victor F. Ganzi

Helene D. Gayle

Louis V. Gerstner, Jr.

Richard Gilder

Robert G. Goelet,
Chairman Emeritus

Sibyl R. Golden

David S. Gottesman

C. Robert Henrikson

Norma W. Hess

Richard E. Jaffe

Helene L. Kaplan

Katheryn P. Kempner

Frederick A. Klingenstein

David H. Koch

Shelly B. Lazarus

Ilene Sackler Lefcourt

Thomas E. Lovejoy

Linda R. Macaulay

Lorne Michaels

Roberto A. Mignone

Irma Milstein

Edwin H. Morgens

Charles H. Mott

Richard D. Parsons

Valerie S. Peltier

Charles E. Phillips, Jr.

Alan Rappaport

Richard L. Revesz

Richard Robinson

Theodore Roosevelt IV

Jonathan F.P. Rose

Ralph L. Schlosstein

Walter V. Shipley

Frank V. Sica

Anne Sidamon-Eristoff,
Chairwoman Emerita

Laura Baudo Sillerman

Mary C. Solomon

Kenneth L. Wallach

Rosalind P. Walter

Judy H. Weston

EX-OFFICIO TRUSTEES

Hon. Michael R. Bloomberg
Mayor of the City of New York

Hon. Christine C. Quinn
Speaker, the Council of the City of New York

Hon. William C. Thompson, Jr.
Comptroller of the City of New York

Hon. Scott Stringer
President of the Borough of Manhattan

Hon. Adrian Benepe
Commissioner, Department of Parks and Recreation

Hon. Kate D. Levin
Commissioner, Department of Cultural Affairs

Hon. Joel I. Klein
Chancellor, New York City Department of Education

HONORARY TRUSTEES

Philip F. Anschutz

William S. Beinecke

Roland W. Betts

Melinda Blinken

Daniel Brodsky

Raymond G. Chambers

Donald K. Clifford, Jr.

L.F. Boker Doyle

Hughlyn F. Fierce

Emily H. Fisher

Elbridge T. Gerry, Jr.

Earl G. Graves

Arthur Gray, Jr.

Alan C. Greenberg

David A. Hamburg

Richard A. Jalkut

Harry P. Kamen

Deborah C. Kessler

David H. Komansky

Lansing Lamont

Karen J. Lauder

Richard S. LeFrak

William M. Lewis, Jr.

Caroline Macomber

Shirley M. Malcom

Norman S. Matthews

William F. May

Eugene R. McGrath

Edward H. Meyer

R. William Murray

Morris W. Offit

Jeremiah P. Ostriker

Lionel I. Pincus

Kathleen I. Powers

Janet Ross

Jack Rudin

Peter J. Solomon

Constance Spahn

Alfred R. Stern

Oscar S. Straus II

Carroll L. Wainwright, Jr.

Edward O. Wilson

In 1993, the American Museum of Natural History created the Center for Biodiversity and Conservation (CBC) to enhance the use of scientific data to mitigate critical threats to global biological and cultural diversity. The CBC develops strategic partnerships to expand scientific knowledge about diverse species and ecosystems, and to apply this knowledge to conservation; develops professional, institutional, and community capacity for biodiversity conservation; and heightens public understanding and stewardship for biodiversity. Working both locally and around the world, the CBC develops model programs that integrate research, education, and outreach so that people—a key factor in the rapid loss of biodiversity—will become participants in its conservation.

The CBC's programs focus on areas of the world where biodiversity is richest and most threatened, as well as on taxa that have traditionally been neglected in the conservation process, such as invertebrates. Raising awareness and promoting conservation action are also CBC imperatives, and through symposia, workshops, and publications we help to inform the public about biodiversity issues. To make the complex political and economic decisions necessary for the protection of global biological resources, people must have the scientific tools to identify and understand the mechanisms behind the threats to biodiversity. The CBC strives to equip the world community to use these tools effectively. <http://cbc.amnh.org>

BIODIVERSITY ADVISORY COUNCIL

Sibyl R. Golden
Chairman

Ellen V. Futter
President

Michael J. Novacek
Senior Vice President and Provost of Science

John Alexander
George Amato
Lewis W. Bernard
Peggy Bewkes
Melinda Blinken
Margaret Condron
Dorothy Cullman
Edgar Cullman, Jr.
Robert DeSalle
Vivian Donnelley
Pamela Stedman Farkas
Nancy B. Fessenden
Emily H. Fisher
Kathryn Hearst
Meg Hirschfeld
Richard E. Jaffe

Theodore Janulis
Karen J. Lauder
Thomas E. Lovejoy
Edwin H. Morgens,
Chairman Emeritus
Valerie C. Ohrstrom
Valerie S. Peltier
Theodore Roosevelt IV,
Chairman Emeritus
Jonathan F.P. Rose
Anne Sidamon-Eristoff
Peter Solomon
Constance Spahn
Eleanor Sterling
Melanie L. J. Stiassny
Edward O. Wilson

Throughout its history, the American Museum of Natural History has made many contributions in exploration, discovery, and technical advances in the natural sciences. Central to these efforts has been the accumulation of one of the world's pre-eminent museum collections—more than 32 million specimens and cultural artifacts—an irreplaceable record of life on Earth, which supports the Museum's cutting-edge research. Today, the Museum is in one of the most active periods of collecting in its history, including building new types of collections such as frozen tissues and vast electronic databases supporting genomics and other research.

In the emerging field of genomic science, the Museum has a unique role—that of exploring genomics as a comparative, rather than single-species, discipline. For more than a decade, the Museum has fostered pacesetting research on the genetic makeup of a great diversity of species. Such research allows scientists to map the evolutionary relationships among organisms, enhance efforts to conserve biodiversity, successfully retain genetically healthy populations in threatened habitats, and understand infectious diseases.

To effectively organize and build upon these remarkable gains in genomics research, the Museum established, in Spring 2001, the Institute for Comparative Genomics. In 2007, the Institute was named The Sackler Institute for Comparative Genomics, in recognition of the major support of the Mortimer D. Sackler Foundation. The Museum and the Institute's approach considers the 3.8-billion-year history of life as a grand biological experiment, one whose observation requires the integration of molecular, anatomical, and paleontological data. That effort has now become the focus for more than 70 research staff using facilities that include modern molecular laboratories, substantial bioinformatics capacity, and a frozen-tissue collection facility. These, together with research partnerships with other prominent scientific institutions, position the Museum to enhance its important contributions to genomics research, particularly in microbial science. <http://genomics.amnh.org>

