24 August 2004 For Immediate Release
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The Global Crisis in Biodiversity
The Critical Role of Museum Collections

Just what is "biodiversity"?

Biodiversity is a one-word name for all the species on earth, the genetic variety they possess, and the ecological systems in which they live. Think of biodiversity as the "living resources" part of "natural resources".

Biodiversity is expressed on at least three levels: genetic diversity, species diversity, and habitat/ecosystem diversity (National Academy of Sciences, 1995):

Genetic diversity within each species reflects the fact that individuals have subtly different genetic material. Because of that, a small number of individuals can not contain the full genetic potential that exists within a species, any more than one human family can contain the full diversity of humanity. Only large populations of individuals can encompass the genetic heritage of a species.

Species diversity reflects the divergence of organisms through evolutionary time. The diversity of species we see in the world today is the end result of a process of genetic change and divergence through millions of years and millions of generations.

Habitat and ecosystem diversity reflects the different climatic and biological histories of different parts of the earth. Different environments place different demands on organisms. Hence we find different networks of biological function in different places. No two places are identical, and the degree to which they differ controls the difference in their biological resources.

Why is biodiversity important?

Humans depend on the richness of the diversity of life on earth for survival. Biodiversity itself (not just the existence of biological resources) provides direct benefits to humanity as a whole and to specific human communities:

Economic benefits – new forms of food, variety in raw materials for construction, novel medicines based on bioactive compounds, tourism.

Ecosystem services – cleansing of air and water despite habitat change, potential for adaptation to environmental change.

Aesthetic and social services – cultural benefits from diverse biological surroundings, relaxation and inspiration, new knowledge that we have not even imagined.

Preserving and understanding biodiversity, on all levels, is critical for us to live well in the future. Because we have such a crude understanding of the breadth of life on earth, we also have an ethical responsibility to preserve as much diversity as possible for future generations.

> *If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.*
> Aldo Leopold. 1949. A Sand County Almanac: And Sketches Here and There.

What is the problem with biodiversity today?

Biodiversity is being lost at an astonishing rate. Since our knowledge of earth's biological diversity is so poor, estimates of what is being lost are only approximate. Recent estimates are that 10% of species are threatened with extinction now. Connecting this with the rate of loss of habitat diversity, and it is possible that one-third to two-thirds of all species will go extinct in the second half of this century (Raven, 1999).

The Earth has seen comparable mass extinctions only a few times during its history. Each time in the past that the earth has sustained such high levels of extinction, the world's ecosystem changed radically. Every species that went extinct, of course, never returned. However, even entire groups of species were unable to survive such ecological shifts. The best known such loss was the extinction of all the large dinosaurs 70 million years ago.

There is little reason to suppose that we will fare better than the dinosaurs unless we succeed in understanding the biodiversity around us and use that knowledge to stem its loss.

Why are museum collections involved?

The collections that are kept in natural history museums are the world's library of biodiversity. Museum collections of specimens, like library collections of books, are the place to which researchers and practitioners go for reference information. Unlike multiple copies of a book in various libraries, however, each specimen in a collection is unique, a single biological snapshot from one place and one time.

The particular expertise needed to recognize and describe the diversity of life on earth exists primarily at museums. For most species in the world, even basic identification to the species level is a challenge. That work happens largely in natural history museums. The most basic question in biodiversity studies is: "What is this organism?" In many cases, the only way to answer that question is by having a museum expert compare specimens with those that are already in the collection.

In some cases of rare or under-researched organisms, museums may have only one or a few specimens. These specimens may encapsulate all we know about a species. In many cases, however, museums have multiple specimens of a species. By having individuals collected at different times and different places, it is possible to use them to examine biological change through time and across broad territories.

Natural history collections have been used for a broad variety of work that required samples through time or space (Suarez and Tsutsui, 2004):

- The origins of "new" human diseases are being examined by looking at museum collections of animals made through decades of time.
- Biological invasions are being detected and tracked thanks to existing collections that preceeded the invasions.
- Historical specimens are being analyzed to determine the history of environmental contaminants that affect human health.

Restoration projects seeking to return damaged lands or waters to their original state need to know what the initial state was. In many cases, museum collections provide the only known record of the biota that existed before we changed things.

How is the Marine Biodiversity Processing Center involved?

The mission of the Marine Biological Processing Center (MBPC) of the Natural History Museum of Los Angles County is to provide the best possible processing for biodiversity samples. This includes the initial assessment and handling of collections that are arriving from research expeditions and collecting trips, through the proper curation of the specimens and their accompanying data.

Proper curation of natural history specimens is a challenging technical enterprise. The goal is to ensure that specimens (and their accompanying collection data) are preserved in a way that will permit optimal research use now and in the future. For most marine specimens, this means some form of "wet preservation" in a long-term preservative solution. Historically, preserving the form of the organism was the goal. Now, of course, modern molecular research demands preserving the organism's DNA as well, adding to the challenge of proper curation.

The MBPC is the point of first contact for biological specimens when they arrive at the Natural History Museum. Following the MBPC's processing, specimens for which there is a curatorial expert at the Museum (crustaceans, echinoderms, polychaete worms, and mollusks) are distributed to the appropriate section. The MBPC maintains collections of other marine invertebrate specimens (e.g. sponges, cnidarians, flatworms, tunicates, etc.).

An important aspect of making museum collections useful is disseminating information about their holdings. Just like a library full of books, it is much easier to use a museum collection full of specimens when there is an electronic catalog of the holdings. The MBPC is at the forefront of the Museum's efforts to make information electronically available.

Ultimately, the MBPC is using the time, energy, and expertise of its staff to enhance our understanding of Earth's biodiversity so that we will all benefit by knowing our planet better.

Background materials

National Academy of Sciences Committee on Biological Diversity in Marine Systems. 1995. *Understanding Marine Biodiversity: A Research Agenda for the Nation.* National Academy Press.
Excellent summary of many biodiversity-related issues.

Ponder, W.F., G.A. Carter, P. Flemons, and R.R. Chapman. 2001. Evaluation of museum collection data for use in biodiversity assessment. *Conservation Biology* **15**(3):648-657.
Technical paper looking at a statistical approach for using museum collection data.

Raven, P. 1999. Plants in peril: What should we do? *Remarks at the XVI International Botanical Congress, Aug. 1-7 1999, St. Louis, MO.*
Includes estimates of biodiversity loss.

Suarez, A.V., and N.D. Tsutsui. 2004. The value of museum collections for research and society. *BioScience* **54**(1):66-74.
Lists numerous examples of the applied use of museum collections.

Yates, T.L., *et al.* 2002. The ecology and evolutionary history of an emergent disease: Hantavirus pulmonary syndrome. *BioScience* **52**(11):989-998.
How museum collections of desert rodents allowed medical researchers to pinpoint the origin of a fatal virus in the U.S. Four Corners area during the 1990s.