Natural History Museum Collections in the 21st Century
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As whole ecosystems continue to be lost because of human activities, the need for natural history collections is more important than ever. These collections:

- provide essential research in the biological sciences.
- serve as a vast library about what organisms have lived and are living on Earth.
- contribute to public education in an easily accessible venue.

According to most dictionaries, the term “natural history” has a connotation of amateurism. As far as natural history museums and collections are concerned, nothing could be further from the truth. For that reason, many prefer the term “natural science.”

The modern natural history museum with its dinosaurs, live insects, and breathtaking displays of gems and minerals is a wonderfully accessible place for popular science education. Children around the world love to visit natural history museums. But in most cases, behind the public face of such institutions lies the entirely different world of the collections—several hundred thousand or even many millions of specimens of living organisms or fossils, maintained with great care and at great expense. The subject matter of the natural history collection or museum may range from zoology, botany, entomology (which historically has always been categorized separately from zoology), paleontology, and mineralogy to zoology and anthropology. These collections are the foundation for research on some of the fundamental phenomena of biological science: evolution, ecology, climate change, biogeography, behavior, agriculture, and, if they include the human sciences, culture. But they face a changing and uncertain future.

Apart from the obvious need to preserve these collections for science (which sometimes runs contrary to the need to make them accessible to the public), all natural history collections are fundamentally concerned with three concepts.

- **Information.** Natural history collections together form a huge library of information about what organisms have lived and are living on Earth. A pharmacologist wanting to know where to find relatives of a particular medicinal plant, a paleontologist trying to understand the patterns of evolution, an ecologist developing theories of the changes in distribution of a species in space and time, a conservationist wanting to know the diet 10 years ago of a fish in a now-polluted stream, an agricultural scientist studying insect pests and resistant plants, a molecular biologist looking for DNA from an extinct species all find essential information in a natural history collection.

- **Identity.** Everything begins with the real object—the specimen—which must be correctly identified as to species or kind and also placed accurately in space and time: where it was collected, when, how, and by whom. A specimen that has lost its label is almost useless; a specimen with its label is a mine of information for those who can read it. Everything depends on the information being accurate and up-to-date. It follows, then, that if specimens lack this sort of information, they are less valuable to science, although they may still be useful for exhibition.

- **Comparison.** The collections of most major natural history museums include millions of specimens, some collected over 200 or more years ago, and including ancient fossils. Increasingly, the collections include
patterns of the past and present and to predictions of future change.

Without early collections, many species would be unknown.

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Collecting also involves recording environments, from soil types to climates.

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DNA and tissue samples. By comparing specimens collected across space and time, scholars can not only discover the patterns of past and present natural phenomena (such as climate change or continental drift), they can look for the underlying causes and then predict the course of future change.

Collecting then and now

The hey-day of collecting was probably the Victorian age, when collectors fanned out across the globe, risking life and limb, usually without much regard to the sensibilities of the country and people involved, to bring back literally everything they could find. Such blanket collecting—taking the common with the rare, and a few of each species, instead of carefully targeted, statistically valid sampling—is now unfashionable. Large collections are very costly to maintain; the whole political context is against it. However, it has to be said that if our predecessors had not collected so broadly, many species would currently be unknown to us, lost in the accelerating pace of environmental degradation of the 20th century. All too many species, from the Tasmanian thylacine “wolf” to the dodo and passenger pigeon, exist only as museum specimens.

Collecting of the more traditional kind—one of every species and every variant—is still very common among amateur collectors. But for professionals collecting is more focused today. Museum scientists tend first to identify a specific problem and then collect what is needed to answer the question. All collecting, even at home, must be conducted with a careful view to laws and property rights. Apart from entirely reasonable national sensibilities, many organisms have huge financial potential in the pharmaceutical industry; collecting abroad must always involve careful and diplomatic preparation, formal permissions, and usually an agreement to share the specimens with the source country.

The importance of collections and the work of collection-based scientists continues to grow.

• Whole ecosystems continue to be lost due to human activity and it is the essential task of natural scientists not only to collect specimens of the living organisms for present and future science, but also to record the environments in which they live, from soil types to climates.

• Technology has changed. Preservation of the specimens themselves and the data accompanying them constantly become more rigorous and demanding. Whereas in the past a collector might simply have recorded a locality as “Patagonia” or “Rocky Mountains,” now it is possible to get a precise GPS fix. Whereas older specimens were dried or preserved in alcohol, and though much information can still be obtained from them, today there is the possibility of making collections of tissue samples or seeds deep frozen (cryopreserved) for molecular studies.

• A whole range of new uses for museum collections now exists. In particular, molecular biologists, who in the past have scorned natural history collections, have come to realize their importance. Likewise, the scientists working in the collections have adopted the latest techniques of molecular biology for the own work of identification and comparison. One fascinating approach is to develop a simple “bar code” identification (the sequence of a short section of mitochondrial DNA) for species, a task that would be impractical, and for extinct species impossible, without museum collections.

• Collections are most useful when they extend across the whole range of a species. This is important when local populations are at risk of extinction, as it is possible to determine whether they are unique or not. For example, in the late 1980s, the northern spotted owl was at the center of debate over logging of West Coast forests in the United States. Careful study showed that there were three subspecies faced with different levels of threat.

• Collections are even more useful when they have been made in the same places over a long period of time. Then historical trends can be uncovered. Not only can one describe changes in the distribution of particular species, by looking at the chemistry of the tissues and at
Museums hold onto every specimen, despite changing trends.

Natural history collections are suffering from a serious decline in resources.

We must find ways of getting the public involved.

The stomach contents, the changing ecology of the species can be unraveled. This is important in determining the effects of human activity in historical time and distinguishing that from natural causes of change.

The 50-percent paradox

It is an old saying in business that half of all money spent on advertising is wasted, but nobody can tell which half. Similarly in museums, at any one time it may be urgent or fashionable to study a particular group of organisms or a particular phenomenon. The rest of the collections are unused. But 25 years in the future, a different subset of the collections will be in constant use. Who would have thought it important in 1950 to save broken bits of peregrine falcon eggshell collected over the last century? Or that, after Rachel Carson's book *Silent Spring*, such fragments would be essential for documenting the lethal effect of DDT on eggshell thickness worldwide?

The advantage of the museum collection is that it is constituted to hold onto every specimen, even in the face of changing fashions. Collections are like stock market investments; the sensible investor is interested in the long view and does not react to short-term issues. This then leads to a paradox: One of the most obvious measures of success is growth of the collections, but museums cannot grow indefinitely.

Despite their ever-growing importance, natural history collections, like most other aspects of the museum world, are suffering from a serious decline in resources. This comes at a time when every cost associated with developing, maintaining, and using research collections is rising. The first challenge to the future museum, therefore, concerns resources: Most natural history museums are under serious budget constraints, and the number of trained professionals they employ is declining. The profession is forced to find ways of continuing to develop the research potential of museum collections while learning how to live with reduced resources. Meanwhile, whole fields of expertise are at risk because no young professionals are being trained to take the place of those who retire.

A second challenge (also common to all kinds of museums) is to find more, and more dynamic, ways of integrating the public with the research uses of collections. If that can be developed, the opportunities for funding will grow. The main new opportunities are in the field of computer-based access to information. Four issues in particular will preoccupy the 21st century natural history collection:

- Growth of collections seems inevitable; we do not know what proportions of the world’s living species have been found and identified. We only fear that it may be less than 50 percent, even 10 percent. Therefore collecting, particularly of small to microscopic species and of new kinds of samples, will remain an essential activity of museums. But it is not known who will pay for the facilities needed or where the next generation of skilled professionals will be trained.

- Computers have long been at the heart of museum information systems. One of the main tasks at the moment is to collect the information dispersed in the collections of different institutions into discrete searchable databases (with images) that users can access remotely. This is well under way in many areas but is very costly in terms of human power if it is done well (that is, data are checked before being included). Another digital advance will be the development of software for species identification. These systems and databases can then also be the foundation for new modes of online public access and educational programming.

- Many museums have collections that no longer fit their research purposes. An obvious, if unpopular, step would be rationalization, that is, the physical exchange of whole collections among institutions in order to build strengths in particular areas in given museums.

- Even more unpopular would be to make unused and unusable collections inaccessible. But this has to be considered seriously in order to maximize use of resources.

Perhaps the greatest overall challenge for natural science collections is for the
New strategies for public access are essential to the modern museum.

great research museums to dispel, once and for all, the image of collections sitting somewhere in the basement of a building, the specimens and their curators gathering dust together, and all devoted to some arcane exercise of identifying and classifying the results of someone else's science. The reality is that the modern museum is a constantly evolving entity, home to a heady mixture of sciences—evolution, biogeography, environmental biology, human biology, geology, and molecular biology—all in the context of growing public interest and a need for new modes of public access.

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ActionBioscience Article
“The Weight of a Petal: The Value of Botanical Gardens.”
Bruce Rinker’s article on ActionBioscience.org explains the history, mission, and value of botanical gardens.
http://www.actionbioscience.org/biodiversity/index.html

BioScience Article
“Natural History Museum Visitors’ Understanding of Evolution.”
Not only can natural history museums provide essential research in the biological sciences, and serve as a vast library about what organisms have lived and are living on Earth, Natural history museums are the principal repositories of the collections that represent much of the objective evidence for evolution. With approximately 50 million visitors annually, U.S. natural history museums can significantly influence the public’s understanding of evolution. In this November 2007, BioScience article, Bruce J. MacFadden et al. present the results of a study that investigated the knowledge of key evolutionary concepts exhibited by high-school students and adults who visited natural history museums. Read the abstract, or log in to purchase the full article.
http://caliber.ucpress.net/doi/abs/10.1641/B571010

Natural History Collections and the Digital Library
The May 2004 article, “Determining Space from Place for Natural History Collections,” in D-Lib Magazine explains the importance of digitizing specimen data.
http://www.dlib.org/dlib/may04/beaman/05beaman.html

Are Museums’ Specimen Collections Going Extinct?
A National Geographic article explores why natural history museums are at risk because the supply of scientists needed to manage them is drying up.

The National Museum of Natural History
A description of the types of collections in this museum.
http://www.mnh.si.edu/rc/
Society for the Preservation of Natural History Collections (SPNHC)
SPNHC is a multidisciplinary organization composed of individuals who are interested in
development and preservation of natural history collections. Become a member, read their online
newsletter, or find out about events and meetings.
http://www.spnhc.org

Natural History Museum Directories
Visit a natural history museum near you or take a virtual tour.
http://www.ucmp.berkeley.edu/subway/nathistmus.html
http://www.lib.washington.edu/sla/natmus.html

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» Pergams, O., and N. Nyberg. 2001. Museum collections of mammals corroborate the exceptional decline of prairie habitat in

For Educators: Fossils Classroom Activities

» The Virtual Fossil Museum
Fossils across geological time presented in multiple contexts of geological history, the tree of
life, paleobiology and evolution. The Virtual Fossil Museum is an educational resource providing
an ever-growing extensive collection of fossil images.
http://www.fossilmuseum.net/

» Fossil Dating and the Geological Timeline
Several activities and information about dating fossils and placing them in the context of the
history of life on Earth. Includes background information for teachers. For grades 5-8, but
activities can be easily modified for higher grades.
http://www.acad.carleton.edu/curricular/BIOI/classes/bio302/Pages/TKpage2.html

» Human Evolution: Interpreting Evidence
Fossil fact sheets, research questions, activities, and more.
http://www.mos.org/evolution/resources