collective KNOWLEDGE
The Value of Natural Science Collections
MUCH OF WHAT WE ARE BEGINNING TO UNDERSTAND ABOUT OUR WORLD, we owe to the collection, preservation, and ongoing study of natural specimens. Properly preserved collections of plants, animals, rocks, soil, ice, insects, birds, and fish are libraries of Earth's history, and vital to our ability to learn about our place in its future.
COLLECTING IS A HUMAN PURSUIT

Our inquisitive nature compels us to gather intriguing objects and make sense of them. A collection of pebbles made by a cave dweller some 80,000 years ago in France is perhaps one of the earliest examples of the desire to collect.

Not until the 18th century did collecting become a truly organized pursuit. Carolus Linnaeus (1707-1778), considered the “Father of Taxonomy,” devised a system to name and organize all living things. Widespread adoption of this system inspired a great age of methodical discovery and collection of the natural world. Each newly collected and identified specimen now contributed to an organized worldwide survey.

ex. Bullsnake (Pituophis melanoleucus)

<table>
<thead>
<tr>
<th>KINGDOM</th>
<th>PHYLUM</th>
<th>CLASS</th>
<th>ORDER</th>
<th>FAMILY</th>
<th>GENUS</th>
<th>SPECIES</th>
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<td>Rhyynchocephala</td>
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<td>Anguidae</td>
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<td>Brachiopoda</td>
<td>Amphibia</td>
<td>Squamata</td>
<td>Helodermatidae</td>
<td>Phyllophicyxus</td>
<td>&gt; melanoleucus</td>
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<td>Plantae</td>
<td>Bryozoa</td>
<td>&gt; Reptilia</td>
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<td></td>
<td>&gt; Pituophis</td>
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<td>&gt; Animalia</td>
<td>Chaetognatha</td>
<td>Aves (Birds)</td>
<td>Mammalia</td>
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<td>&gt; Chordata</td>
<td>Cnidaria</td>
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Canis latrans excolatus
Coyote, Quinzeville, British Columbia
C. H. Harbour
1901
<table>
<thead>
<tr>
<th>KINGDOM</th>
<th>Animalia</th>
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<td>PHYLUM</td>
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<td>GENUS</td>
<td>Canis</td>
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<tr>
<td>SPECIES</td>
<td>latrans (coyote)</td>
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Today, much scientific study relies on the data held in research collections. Assemblages of organisms, minerals, and artifacts are the building blocks providing insight into Earth's past, present, and future.

*collections REVEAL A FIVE BILLION YEAR HISTORY of changes in Earth's geology, climate, and life forms.*

*collections HELP US TO MAP the locations and health of the planet's biodiversity and natural resources.*

*collections POSSESS KEY INFORMATION that we use to protect our natural resources.*

*collections PROVIDE MATERIALS for new drug therapies and insight into diseases.*

*collections INSPIRE PEOPLE of all ages and interests, through museum exhibitions, natural history guides, and educational programs.*

*collections TEACH US...*
about CLIMATE

In 1804, Meriwether Lewis and William Clark would have been astounded to know that the plants collected on their celebrated exploration of the American Northwest would be used centuries later to study pollution and climate change. Mark Teece, a chemist with the State University of New York, is studying the collection to compare current levels of atmospheric carbon dioxide concentrations and environmental growth conditions in western North America with those prior to the industrial revolution and the chemical changes it brought to the world's atmosphere. Held at the Academy of Natural Sciences, the Lewis and Clark Herbarium collection is a national treasure representing the earliest transcontinental collection of plants. Despite being 200 years old, this collection holds the environmental signature of its time, enabling Teece to compare changes in concentrations of gases, rainfall, drought, and temperature to the signature of today's plants. Such studies are making critical contributions to our understanding of climate change.

Climate in Collections

Deep layers of mud, sand, rock, and ice contain fossilized life forms and mineral signatures of the Earth's past. Researchers collect cores of these sediments to understand ancient climate change scenarios, which reflect on our future. Core collections are also used to detect locations of valuable natural resources.
Aristida purpurea Nutt. var. longiseta (Steud.) Vasey

DET. K.W. Allred

NEW MEXICO STATE UNIVERSITY, RANGE SCIENCE HERBARIUM

107646
HERBARIUM
FIELD COLUMBIAN MUSEUM
Aristida longiseta Steud.

COLORADO FLORA.
Near Boulder.
AS THE EARTH RESPONDS TO CLIMATE CHANGE, shifts in ecosystems are expected to follow. The preservation of biodiversity may depend on our ability to predict how species will react. A. Townsend Peterson, a biologist at The University of Kansas, is making such predictions using Species Analyst, an online catalog linking together some 55-million collection specimens from algae to mammals. Peterson is tracking how mountain and Great Plains birds of central and western North America will cope with the predicted rise in temperature over the next 50 years. Species Analyst provided a list of birds known to these locales, which was used to develop models of ecological needs for each species. Overlaying these needs with how temperature ranges will change the landscape, Peterson shows that plains birds will be the most severely impacted by climate change, with some species receding to very small areas. With this information, conservation strategies can be developed to eliminate barriers preventing birds from finding habitats to sustain their population.
about MEDICINE

IDENTIFYING PLANTS AND OTHER ORGANISMS, knowing where they grow, and recognizing conservation needs are crucial to drug discovery and can only be achieved using established research collections. Every year the Missouri Botanical Garden (MOBOT) sends tens of thousands of plant collections to labs worldwide that are developing new drug therapies. Several years after the MOBOT sent a vine collected in Cameroon to the National Cancer Institute for screening, it learned that chemicals in the vine held promise for preventing the transmission of HIV/AIDS from mother to child. The plant had been identified as a common vine; however, newly collected specimens were not showing the same anti-HIV activity. MOBOT researchers returned to Cameroon to compare the original plant to the voucher specimen held in their five-million-specimen research collection. It turned out to be a case of mistaken identity—the vine was entirely new to science and, as a survey revealed, very rare. Efforts are underway to cultivate this promising new species so that its small wild population will not be wiped out.

MEDICINAL PLANTS

White Willow .................. aspirin
Quinine ........................ anti-malarial
Foxglove ....................... heart regulator
Madagascar Periwinkle ...... cancer treatment
Aloe* .......................... burn treatment
Chili Pepper ................... pain blocker

(Thousands of species are used medically)
about EXTINCTION

DUBBED “THE EXTINCTION CAPITAL OF THE WORLD,” Hawaii experiences one of the highest extinction rates on Earth. Sadly, more varieties of Hawaiian plants and animals exist in the collections of the Bishop Museum than live in the wild today. Representing a history of Hawaii’s land, freshwater, and marine species, the Bishop Museum’s four-million-specimen beetle collection plays an essential role in ongoing surveys of the existing biodiversity. Al Samuelson, an insect expert with the Museum, recently surveyed the islands for Rhyncogonus, a genus of broad-nosed weevils. Comparing what he found in the wild in recent years with what was collected in centuries prior, he was able to figure out which species are now extinct and which are endangered. It is theorized that the decline of weevils, which are a primary food source for birds, contributed to bird extinctions on the Islands. Of the more than 100 species of birds known to have once inhabited Hawaii, fewer than 35 survive today.

EXTINCT SPECIES

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Year First Described/Recorded</th>
<th>Year Last Reported Sighting</th>
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<tbody>
<tr>
<td>Caribbean monk seal</td>
<td>1494</td>
<td>1952</td>
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<tr>
<td>Bluebuck</td>
<td>1719</td>
<td>1800</td>
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<tr>
<td>Stellar’s sea cow</td>
<td>1741</td>
<td>1768</td>
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<tr>
<td>Tasmanian wolf</td>
<td>1808</td>
<td>1936</td>
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<tr>
<td>Crescent nailtail wallaby</td>
<td>1841</td>
<td>1956</td>
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<td>Desert-rat kangaroo</td>
<td>1843</td>
<td>1932</td>
</tr>
<tr>
<td>Darwin’s Galapagos mouse</td>
<td>1929</td>
<td>1930</td>
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</tbody>
</table>

Source: CREO, American Museum of Natural History

(between 50 and 150 extinctions are thought to occur on Earth each day—UNDP)
about DISEASE

WITH THE THIRD HIGHEST COUNT OF HUMAN CASES IN THE UNITED STATES, Ohio was identified as a hotspot for West Nile Virus in 2001. Joe Keiper, an insect expert at the Cleveland Museum of Natural History, was asked to advise a task force proposing to spray insecticides over large swaths of the Cleveland region. Keiper studied the Museum’s insect collection, estimated to hold 800,000 specimens, including a comprehensive sampling of mosquitoes native to Ohio. Collection records indicated that Culex pipiens, C. restuans, and C. salinarius—the mosquitoes known to transmit West Nile Virus—occur in areas with standing water such as marshes, ornamental ponds, gutters, and sewers. Distinguishing between the breeding habits of these three species resulted in a targeted and highly effective eradication program with significantly less impact on the environment.

ZOONOSES (zō-ôn’ə-sīz) n. a disease of animals that can be transmitted to humans, including:

Lyme Disease
West Nile Virus
Malaria
Anthrax
Yellow Fever
Encephalitis
(among others)
about NATURAL RESOURCES

TWENTY-FOUR HOURS A DAY, seven days a week, officials search for hitchhikers on all air, overland, and ocean cargo entering the United States. The travelers of concern are the invasive pests and pathogens alien to North America. If these invaders become permanently established, they could cost billions of dollars in annual losses to American agriculture. When inspectors encounter an insect that they cannot identify, they immediately consult experts at the United States Department of Agriculture’s Systematic Entomology Laboratory. Thousands of insects are examined annually using the Smithsonian’s 35-million-specimen insect collection, considered among the most comprehensive in existence. Recently, the USDA identified a Mediterranean fruit fly larva, one of the world’s most devastating pests, in a shipment of Spanish clementines. Thanks to the research collection and a fast identification of the larva, officials halted the importation of the fruit, preventing what could have been a massive economic and agricultural catastrophe.

PRESERVING DIVERSITY

Diversity of plant species is vital to the world’s food supply, yet human innovation and development often destroys the landscapes required to maintain diversity. Germplasm and seed collections around the world ensure that we have a well-represented and documented collection of varieties specifically preserved for use well into the future.
about LIFE

IN A DESOLATE REGION OF PATAGONIA LIES AN ASTOUNDING SCENE—hundreds of thousands of 80-million-year-old dinosaur eggs spread across several miles. With 15 to 40 eggs per clutch, the site suggests that thousands of titanosours, among the largest dinosaurs to walk the Earth, visited this place year after year to nest. Luis Chiappe of the Natural History Museum of Los Angeles County led the expedition that discovered the site. The collections are held in Argentina’s Carmen Funes Museum, but many of the eggs, including fossilized dinosaur embryos and skin, are traveling across the United States in an exhibition titled “Tiniest Giants.”

The exhibit shows what field collecting entails from the perspective of paleontologists, geologists, technicians, students, and volunteers who are discovering, earthing, charting, examining, and preparing these fossils. It is one of thousands of exhibitions that bring research collections to the public, inspiring future generations of scientists and natural history enthusiasts.
the future of COLLECTIONS

THE HUMAN SPECIES HAS BEEN EVOLVING FOR MILLIONS OF YEARS, but only in the last few decades have we made such groundbreaking developments as microscopes capable of magnifying what the naked eye can see up to a million times. It has been half a century since we first understood the chemical structure of DNA—the genetic codes to life.

Advancements in x-ray technology have taken CAT scans from the hospital to the science lab to produce three-dimensional maps of the interiors of fossils and other solid objects. As new technologies emerge, specimens and artifacts held in collections are yielding exciting new information, which the Internet conveys at dizzying speeds.

Preservation of collections so that they can be studied with new technologies has never been more crucial. We can only imagine how future tools will reveal even more details about our world.

The institutions that assemble and manage research collections have enormous responsibilities. They must continue to build their collections into broad representations—a range of toads representing all known varieties and areas tells us more than one toad can. They must preserve each specimen and object for future generations—providing acid-free containers, climate-controlled environments, protection against infestation, and ways to preserve DNA. Most importantly, they must make their collections accessible for research and education. Every day, thousands of specimens are loaned to experts around the world for study, continually adding to our knowledge and understanding of life on earth.
PREVIOUS CENTURIES MAY BE REMEMBERED AS THE GOLDEN AGE OF COLLECTING, BUT WE ARE JUST EMBARKING ON THE GOLDEN AGE OF COLLECTIONS RESEARCH.

TAXONOMY, the science of classification, and the collections on which it is based are often marginalized as old-fashioned and dusty. Now, however, they are on the cusp of a revolution that will propel them back into the mainstream of science. Two circumstances make this advance inevitable. First is the renewed awareness that classification is foundational to biology, and thus collections are ultimately even more foundational to biology. If species cannot be identified and that initial datum used to access all that has been discovered about the species, then a substantial part of genetics, biomedicine, public health, agriculture, biogeography, evolutional studies, and ecology are flying blind. Moreover, as few as ten percent of the species of animals, plants, and microorganisms on the planet have been characterized and given a name. Hence taxonomy, even though 250 years old, is still a young discipline. Obviously, the collections on which it is based are priceless in scientific value and in need of constant care and augmentation.

The second reason for the inevitability of revolutionary advance in taxonomy are the quantal improvements in information technology relevant to what it achieved in the past two decades. They have made possible an acceleration of biodiversity exploration. Specimens, including the type specimens on which scientific names are based, can be photographed with high-resolution digital cameras, yielding images that can then be transmitted electronically at a keystroke to any place in the world. At the same time, the taxonomic analyses resulting from such information can be linked to other biological databases from genomes to ecosystems, to enormous benefit to all of biology. ~ E.O. Wilson
Funded by the New York State Biodiversity Research Institute, and the New York State Museum Institute

design        Costello Communications, Chicago
writing       Mary Tobin
photography   Terry Evans –

p. 03          Bullsnakes, various locations and dates, Pinephus melanoleucus sp., 2001.
p. 08          Drawer of northern cardinals, various dates and locations, Cardinalis cardinalis, 2001.
p. 34          Dragonflies, various locations and dates, Libellula luctuosa, Libellula pulchella, Celithemis eponina, Anax junius, 2002

Above images are from an exhibition developed by The Field Museum (Chicago) in collaboration with Terry Evans. The first date is the date the specimen was collected, the second date is the date the specimen was photographed.