



From Our Cabinets to Your Desktop Digitization Projects Make Natural History Collections Available to Everyone

Extinct feather lice, invasive fish from the Great Lakes, and rare plants from Pakistan are a few of the millions of species no longer viewed just in dark academic warehouses and museums. Curators at the Prairie Research Institute (PRI) who have helped to preserve these biological specimens are digitizing them for anyone who is interested in science to view them online.

As part of a 10-year, \$100 million National Science Foundation initiative, PRI scientists at the Illinois Natural History Survey have received numerous grants to digitize portions of their 9.5 million specimens in 11 collections on the University of Illinois campus. These collections hold secrets to the past and serve as an enduring reminder of the rich diversity that nature has to offer.



Natural history collections are stored in dark rooms and cabinets to help preserve specimens.

ABOVE: Researcher Dmitry Dmitriev using Insect Collection

LEFT: Herbarium and Fungarium

BELOW: Mussel Collection and Fish Collection



Fungi

With over 150,000 specimens, the INHS Mycological Collection of both common and rare fungi dates back to the 1800s. Its heavy emphasis on Illinois specimens makes it a unique assemblage of mildews, bread molds, rusts, mushrooms, and other fungi. The database brings the collection together in one place for scientists to explore different environmental aspects, such as how climate change affects the distribution of native and invasive fungi.



ABOVE: Fungal specimen to be digitized
BELOW: Photographing collection label of specimen



"Scientists can use the data for climate change modeling, answering questions such as 'where were they before?' and 'how have their distributions changed over the past 200 years?' said Andrew Miller, lead principal investigator for the microfungi digitization project. A collection can also indicate gaps in our knowledge of biodiversity and provide a baseline from which to continue studies.

One feature of the data is georeferencing, which means to assign latitude and longitudinal coordinates, to pinpoint the location of a particular species on a map. Labels identifying the species typically indicate a location at a given time.

Miller also uncovers samples that may have been missing for over 100 years. New "old" collections are added as they are rediscovered in some forgotten collections or when they change hands when professors retire.

"Some collections have been stuck back in dirty, old, creepy rooms where there is no sunlight," Miller said. "With digitization, we're bringing these collections into the light."

www.mycportal.org

Plants

With a dab of archival glue, plant specimens are attached to paper and stored in climate-controlled conditions to minimize insect and mold damage. Three U. of I. collections total 1.1 million specimens of plants that date back to 1808. Over 90,000 plants have been digitized.

The herbarium collection manager, Jamie Minnaert-Grote, relies on volunteers to help with databasing. Botanists in the field continue to add several thousand specimens to the collection every year.

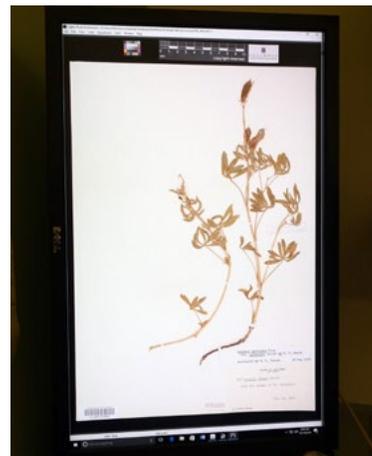
In the past, plant samples were loaned to scientists around the world who would snip a piece of leaf or flower for analysis. The data have been used for molecular

studies of plant DNA, biogeography studies on how species have moved from one location to another, and studies on how various plants are related.

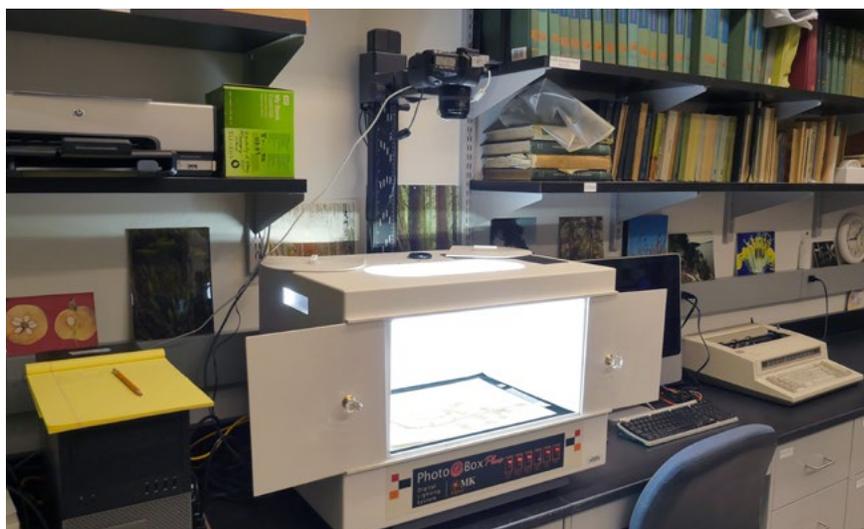
With the digitization project, Minnaert-Grote noted that loans of samples have dropped, as more scientists access the information—and images—online. The database can be useful for students as well.

"This information, which is so readily available, can open the doors for students interested in plants," she said. "A lot of people don't know what a herbarium is. Getting that vocabulary out there so students know what we do is important. This project can make others more aware of the vast biodiversity of plants in Illinois and beyond."

www.midwestherbaria.org



RIGHT: Digital image from process below.
BELOW: Specimen of *Lupinus adsurgens* being digitized.



Mollusks

A digitization project has provided detailed photos of 30,000 freshwater mussels from museums around the world. INHS researchers visited 22 museums in places such as London, Paris, Sydney, Australia, and Brussels, using cameras to photograph specimens and georeferencing images to locations where specimens were found.

Researchers can use this database to find diversity hot spots, or where particular mussel species are most likely to be found.

"You can now view thousands of museum lots via the web," said INHS Curator Kevin Cummings. "Digitization enables examining specimens without having to travel. While it's fun to visit London or Paris, it's also fun to access the information without having to leave your desk."

The full INHS mollusk collection contains nearly 475,000 specimens, including species that have become extinct. Freshwater mussels are particularly vulnerable to human disruption of habitats, from pollution, dams, changing land uses, invasive species, and other factors. For some species, databases and mollusk collections are the only proof that they existed.

Open access through technology is bringing backroom collections to the forefront. What's ahead? 3-D construction of specimens will allow Internet users to spin images around to view all sides, not unlike holding a specimen in your hand and seeing it from every angle.



ABOVE: Curator Kevin Cummings digitizing mussels

BELOW: Digitized specimen from Mussel Project



Mussels specimens from around the world can be viewed at the Mussel Project Web page mussel-project.uwsp.edu/.

Fish

Fish species from around the world make up the INHS Fish Collection, totaling 900,000 specimens dating back over 135 years. For his project, the goal is to photograph 23,000 specimens, said Curator Chris Taylor.



ABOVE: Photo-e-Box used to digitize fish.

One aspect of the project is the collection of invasive species from Midwestern lakes, informing studies about the role of invasive species in the Great Lakes and the damage that fish have caused to the lake environment.

"The Great Lakes are a poster child for all the bad things that can happen," Taylor said. "The lakes have a long history of impacts from invasive species." The zebra mussel, round goby, and other fish that invade lakes degrade habitats and out-compete native species. Invasive species are now available for viewing online and can assist the public in their identification.

For digitization, a technician removes a sample fish from archival jars, sets it into a glass container with fluid, and uses a high-resolution camera to photograph the sample for posterity. Fish scales are plainly visible. Scientists can note fish sizes and characteristics that make each species unique.

With so many specimens in the collection, one benefit to the digitization project is to correct human errors related to location and species identification, Taylor said. A fish captured in 1915, for example, may not have been properly identified or may have been identified in a questionable location. With the acquisitions now widely available, experts can study photographs to correct these errors.

Digitizing the collection increases its exposure and increases peoples' perceptions of the collection's value, Taylor said.

www.inhs.illinois.edu/collections/fish

Insects

In the vast insect collection of 7.3 million specimens located in seven rooms within the INHS, larger insects are stored in vials or pinned in drawers and smaller specimens have been preserved in Canada Balsam (tree sap) on slides. To grasp the vastness of the acquisitions, 100,000 slides of thrips, also called storm flies or corn flies, are filed in a bookcase. The insect collection dates back to the time of Thomas Edison, when electric light was new.

In the digitization process, part-time employees photograph individual insects and entire drawers for online viewing. For specific collections, drawers full of insects can be rotated online to view the label underneath.

As species become endangered or decline, such as the 50 percent reduction in some local bee species, the collection becomes a historic snapshot of the bee population in Illinois, revealing the types of bees in various locations across the state and across time, said Chris Grinter, collection manager.



ABOVE: Camera set up to photograph insects
LEFT: Bumblebee



ABOVE: Insect digitization robot. Click to see video.

"Because some species of bumblebee are so rare now, the collection makes up a lot of what's known about that entire species," Grinter said.

The collection of agricultural pests can be particularly important, even for today's producers. Having a historic window of a particular species informs developments in agricultural production and pest control. Researchers can study changes in insect populations over time to learn how various species have evolved.

"Value is added to the collection as time goes by," Grinter said.

wx.inhs.illinois.edu/collections/insect

Fossils

Tiny remnants of the past encased in amber are a glimpse into the world of over 16 to 20 million years ago. Amber is fossilized tree resin, said Sam Heads, INHS paleontologist.

"When you look up close, you see the microcosm that exists in that piece of amber," he said.

The INHS amber collection is one of the largest and most complete collections of Dominican amber in the world, containing ants, bees, spiders, mosquitoes, and countless other species. Approximately 160 pounds of amber was collected in the Dominican Republic by INHS entomologist Dr. Milton Sanderson in 1959.

The pieces remained in storage until 2011, when processing began. Now, a sophisticated microscope system is used to take high resolution photos for a clear view through the amber to the insects and other fossils within. The images will soon be available to anyone who wants to view them online as part of the NSF-funded Fossil Insect Collaborative project fossilinsects.colorado.edu.

Researchers will use these images and data to study evolution, paleobiodiversity, ancient climate and environmental changes, and to discover new species.



ABOVE: Ceratopogonidae in amber

But it's not all about amber. Many other types of fossils are housed in the PRI paleontological collections which contain over 1 million fossils from all over the world ranging in age from the Cambrian Period some 500+ million years ago, to the end of the last ice age, around 11,700 years ago.

wx.inhs.illinois.edu/collections/fossils

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