Florida's Archbold Biological Station gives online access to unusual natural history collection

The Archbold Biological Station, a world-renowned ecological field station based in Florida, USA, is uploading its natural history collection onto the Internet for the first time. The diverse collection, containing 270,000 specimens of more than 10,000 species will provide researchers and students around the world, with access to this rich source of ecological data. This highly collaborative project, which involves making data and images of thousands of biological specimens available online, is funded by NSF and is being led by **Dr Hilary Swain** and **Dr Mark Deyrup**.

Founded in 1941 by Richard Archbold, a biological explorer, the Archbold Biological Station (Archbold) is an internationally renowned, not-for-profit biological field station located in central Florida. Archbold manages nearly 20,000 acres of land, is dedicated to research and conservation programs, and conducts scientific studies at more than 50 locations throughout the headwaters of the Everglades – a 2.6-million-acre watershed in south-central Florida encompassing those lands and waters that drain south to the Everglades and onto the coasts. The region is one of the most important biodiversity "hot spots" in North America. The endangered Florida scrub is of special interest, being a harsh and stressful habitat that is home to many plants and animals found nowhere else on Earth. Through its research, education and outreach programs, Archbold aims to conserve this biodiversity, and maintain vital ecosystem processes that support Florida's natural environment and its people. The research addresses many of the most important issues facing our world today, such as: climate change, species and land conservation, water quality, and sustainable food production.

Future museum specimens being wrangled from a dead oak; the ecological data will be included on the specimen labels. Photo by Dustin Angell.

The Station is also home to the Archbold Natural History collection – a diverse record of life taken largely from the habitats of the ancient Lake Wales Ridge, a 100-mile-long north-south sand ridge running up the interior of the Florida Peninsula. The 75-year-old collection has grown through the years, and currently contains more than 270,000 specimens and over 10,000 different species. Although smaller than the vast collections at some universities and at large museums, the Archbold collection is valuable in that it is representative of in-depth and very rich regional collections, with a nearly complete local diversity rarely captured elsewhere. "We all believe that natural areas teem with biodiversity," says Archbold entomologist Dr Mark Deyrup. "Here is proof. For example, more than 1,500 species of beetles live on this single site." Overall, it is one of the largest collections for any North American site and includes a wide variety of arthropods, plants, mammals, birds, fish, reptiles and amphibians. It also houses specimens of threatened and endangered plants and animals, giving scientists a unique opportunity to study these rare species. And it includes specimens of many newly arriving species, some of which are invasive, thus tracking changes in Florida's diversity over time. Now, with National Science Foundation (NSF) Collections in Support of Biological Research (CSBR) funding, Dr Hilary Swain and colleagues, aim to share the Natural History collection with a much wider audience, putting Archbold on the global stage.

DIGITAL COLLECTION

During the last couple of years, a team of scientists led by Dr Swain at the Station have been diligently photographing specimens, and adding label information of the flora

and fauna into a searchable database. Significant portions of the collection have been databased and now, for the first time, are being made available online through several national collection portals. This will allow scientists, school children and the general public from all over the world access to this unique collection. To do this, Archbold researchers are working with partner organisation Integrated Digitized Biocollections (iDigBio), an organisation funded by NSF that is making data and images of millions of biological specimens available in electronic format for the research community, government agencies, students, educators, and the general public. Assisted by iDigBio, Archbold staff has currently uploaded approximately 30,000 records of plants, birds and arthropods to online portals hosted by the Symbiota Virtual Biota software package. To date these include 24,000 records of pinned insects available on the Symbiota Collection of Arthropods Network (SCAN), 1,474 records of bird skins available on the Consortium of Small Vertebrate Collections (CSVcoll), and 4,795 herbarium records of pressed plants available on the North American Network of Small Herbaria (NANSH).

In particular, the online arthropod collection is outstanding, as the Archbold Natural History collection is best known for its pinned collection of 250,000 insects, including 137,450 preserved specimens of ants; this encompasses the largest collection of Florida ants in the world. Currently a total of 9,718 ant specimen records – representing 236 species of ants – have been uploaded online to SCAN, including detailed drawings completed by Dr Deyrup (see example opposite). Over the years, the arthropod collection has served as the basis for many scientific papers, contributing to numerous studies requiring insect identification, and was the main source for the Dr Deyrup's 2016 book *Ants of Florida*. The book is a natural history and identification guide for all 239 species of Florida ants.

The collection also includes specimens of insects that were captured feeding on nectar and pollen of local flowers. This record of 'flower-insect visitor interactions' was begun in 1983. It includes more than 5,000 specimens of bees and wasps, 1,500 flies, 200 Lepidoptera (butterflies and moths) and 500 beetles, with labels that record the species of flower being visited by the insect, the location, and the date of capture. So far, a total of 10,868 flower-insect visitor

Above: Museum specimens can reflect major ecological events. Tiny beetles were found in the hidden rotten heart of oaks split by Hurricane Irma on September 10, 2017. Photo by Dustin Angell.

Below: Tiny beetles (sesame seed for reference) found in rotten oak include six species never seen before in 75 years of beetle study at Archbold.

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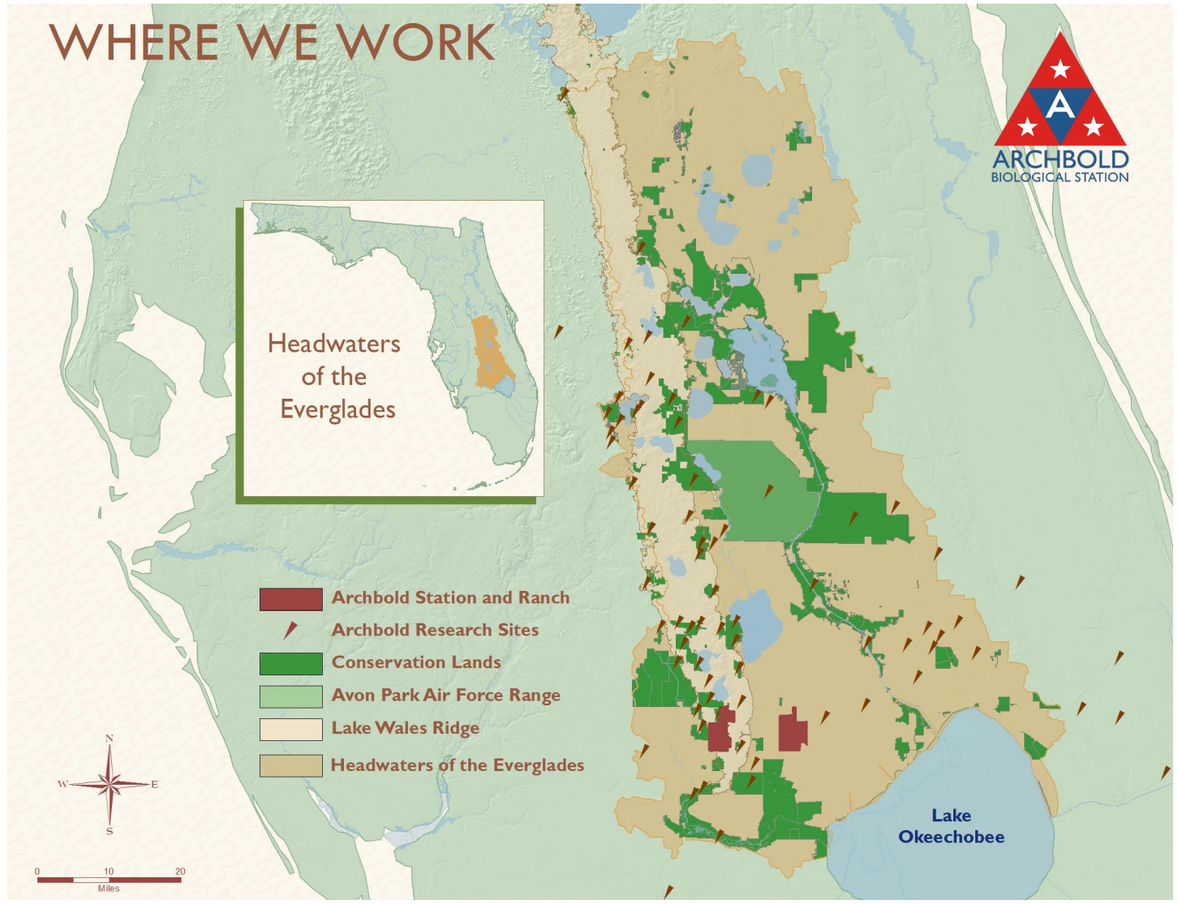
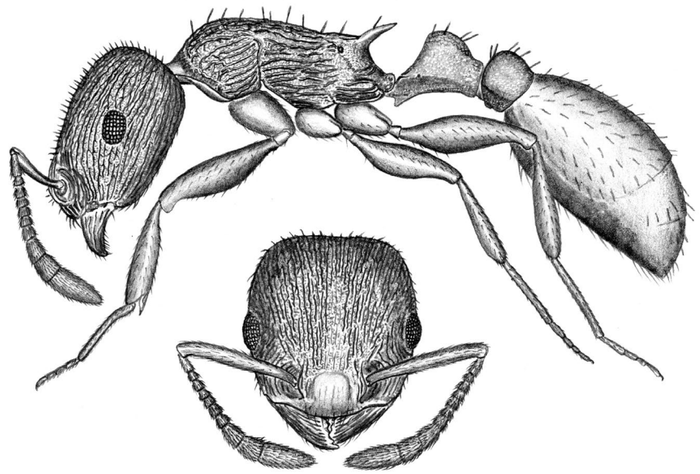


The lands and waters that form the headwaters of the Evergaldes are notable for extensive natural areas that have never been cultivated or strongly disturbed. Here Archbold scientists study species of plants and animals that have been in residence for thousands of years. Figure by Archbold Biological Station.

specimens have been uploaded to the online database SCAN, representing a total of 902 insect species. This ecological dataset is an important resource for biologists, as it can answer questions like: Which bees visit which flowers and when? At the community level, this information is now available to allow researchers to model the stunningly complex network of relationships among flowers and insects at a single site.

WIDENING ACCESS

The online collection will be a huge resource for scientists around the world, providing them with easy access to the data they need to conduct their research. Plant specimens, for example have been used by scientists studying flowering times, which can be affected by climate change. The vertebrate collection provides a vital resource for scientists wishing to study the variation, growth patterns, life histories, and population dynamics of animals. The database will also be of huge interest to



Temnothorax smithi. Multiple specimens in collections allow scientists to determine which features are characteristic of a species and which are variable. After examining many specimens of this ant species in the Archbold collection Mark Deyrup drew this generalised diagnostic image.

The chemical ecology of the Bella Moth (*Utetheisa bella*) has been studied at Archbold for many years. Specimens in the collection serve as archived vouchers, tying together field research and publications.

The 75-year-old collection has been expanded over many years, and currently contains more than 270,000 specimens and over 10,000 different species

schools and children. Archbold has been dedicated to educational outreach for many years. It shares its knowledge and habitats with students of many ages, from age seven through to adult learners. It provides environmental education resources to local schools, as well as access to the site for school field visits and summer camps. It hosts an estimated 2,000 3rd-5th grade and middle school children annually, and nearly 50,000 school visitors have benefitted from its outreach program in the last few years. Undergraduate and graduate university students regularly visit the Station and use Archbold research to conduct field courses or carry out independent field studies. Archbold also provides unique 6-12-month internships, longer than most internships offered by other organisations, where students receive training, participate in research projects and, most importantly, are required to conduct independent research projects of their own design.

The online Archbold collection will make the Station and its work even more accessible to learners and the younger generation. Not only will it be a source of ideas and specimen data for children and undergraduates/graduates from around the world, it will fuel the minds of the younger generation. "This is a giant trove of information for them," says one Archbold researcher. "Advances in computer analyses and graphics will allow the next generation of scientists to swim joyously in floods of data that would drown members of our own generation." Scientists hope that learning to understand and value complexities of the natural world will inspire conservation of rare habitats such as Florida scrub.

•D*ata collection websites to visit: http://symbiota.org (Symbiota Virtual Biota software package), http://symbiota4.acis.ufl.edu/scan/portal/ (Symbiota Collection of Arthropods Network (SCAN)), http://csvcoll.org/portal/ (Consortium of Small Vertebrate Collections (CSVcoll)), and http://www.nansh.org/portal/ (North American Network of Small Herbaria (NANSH)).*

Q&A

Q&A with Dr Hilary Swain, Dr Mark Deyrup and Stephanie Leon

This collections grant is an amazing project to be involved with! What are the major benefits this grant will bring?
Swain: First and foremost, the major benefit of the grant is to enable and enhance more scientific research. As anticipated by our funder, the National Science Foundation, we already see that having Archbold's collection online is shining a light on these data for scientists around the world, not just those who visit Archbold. Whether scientific interests lie in identifying new species, cataloguing biodiversity, highlighting the arrival of new species, noting changes in the timing of flowering, or building complex networking analyses for insect flower visitors, this collection is a treasure trove of ecological information just waiting for scientific discovery and synthesis. Archbold is one of many biological field stations around the world that are important to scientists because although their collections are relatively small, they are extremely important representatives of regional biodiversity.
Leon: One major benefit of this grant is demonstrating the importance of natural history collections, and how they can be used outside of a museum setting. More importantly, the fruits of this grant can demonstrate how a well-curated, regional, on-site collection can provide useful data not only for taxonomy and systematics, but also for ecology and conservation.
Deyrup: Natural history collections are currently cascading onto the Internet, escaping from their reputation as mouldering mortuaries to present their true aspect as enormous and dynamic sources of original information.

Why is it important that a record of life in the Florida Scrub habitat is made and preserved?
Swain: Since scientists first visited the Florida scrub and started collecting specimens of its plants and animals, it has always been recognised as one of the most threatened ecosystems in the USA. Like nowhere else on Earth, there has always been a scientific race to ensure we capture and catalogue all its precious life and unique adaptations.
Deyrup: As we consider our own survival in a world of increasing environmental stress, we could benefit from examining the information and morphology associated with organisms inured to a land of infertile sand, and swept with fires, floods and droughts.
Leon: The Florida scrub is a unique habitat with diverse flora and fauna. It is important to show how such a harsh habitat can support so much biodiversity. This natural history record will also show why conservation of natural areas is important.

How will researchers use this data? What scientific questions could be answered?
Leon: Our data is useful at many levels. It can inform scientists who are interested in the distribution of a particular species, it provides a record of rare and endangered species, it can aid taxonomic revisions and descriptions of new species, and it also provides useful ecological information on plant-insect interactions, primarily pollination. Those interested in pollination ecology can find our "flower visitor" dataset online, download it, and use it to create intricate networks to illustrate the complexity of these relationships.
Deyrup: As data and images of expertly prepared natural history collections go online they become a kind of universally accessible museum – with the added feature that every scientist can rearrange the "exhibits" to further their individual goals.

How will school children benefit from accessing the database?
Swain: Children are natural observers. Their curiosity especially draws them into the spectacular photography of our plants, birds, and the bugs in the online databases. Their faces watch with awe as a small bug looms large on the screen: they see the spectacular colours and intriguing shapes. Here lies inspiration for a future structural engineer, computer modeller, fashion designer, or budding ecologist. Hopefully it will also draw them into the natural world where they can use their sharp and laser-focused eyes to be further intrigued by nature.
Leon: Children will learn about the diversity found in the Florida scrub. It might encourage exploration, not only of the scrub, but of different natural habitats. It might also supplement their learning, research projects, and general interest of biodiversity. Many children that visit Archbold are given tours of the Arthropod collection; they learn about the vast diversity of insect species collected at Archbold. This might entice some to start their own personal collections.

How will the archive further conservation efforts in Florida?
Swain: Biodiversity is in flux worldwide, and nowhere more than in rapidly changing and threatened ecosystems like the Florida scrub. Apart from the obvious conservation question, "What is out there", we can use a collection like Archbold's to inform conservation in many different ways. How is biodiversity responding to changing environmental conditions over time? What new and potentially invasive species are arriving? How does conservation management, such as prescribed fire, benefit species of concern? Are we inadvertently overlooking ecosystem components that are more critical for conservation than we realise, such as Mark Deyrup's long-term fascination with documenting all the insects supported by recently burned, dying, dead, and decomposing wood.
Leon: Our goal is to demonstrate that natural history collections can function jointly with ecological research and conservation efforts. In order to do this, we have to showcase the biodiversity of this unique habitat, and how this biodiversity might be changing over time. Rare, endangered plants are an example of how we can use historical records to track changes in their distributions, and also track the history of invasives, to aid in conservation and/or restoration efforts.
Deyrup: Florida has an exploding human population and amazing numbers of invasive species, combined with impending effects of climate change on a vulnerable landscape. Collection records give a baseline of species diversity and distribution, allowing targeting of conservation. As the richness of Florida's natural heritage becomes easily visible through natural history archives it should inspire the next generation of conservationists.

Detail

RESEARCH OBJECTIVES

Dr Swain, Dr Deyrup and their collaborators' aim is to increase digital access to the Archbold Collection, enabling studies of biodiversity in ways that would be difficult to replicate elsewhere, and enhancing its conservation value as a critical repository for species of the globally threatened Florida scrub. In addition, this project aims to offer students and research interns more opportunities for use of the collection as a source for research ideas and study specimens, as well as provide new mentoring for this next generation of field station users in the importance of collections.

FUNDING

National Science Foundation (NSF)

COLLABORATORS

Co-Project Investigators: Dr Mark Deyrup, Dr Reed Bowman, Dr Eric S Menges, Dr Betsie B Rothermel, Stephanie Leon and Stephanie Koontz.
Research Interns: Gabrielle LaTora, Carly Tolle, Ryan Huether, Dylan Ricke, Katherine Beigel and Trevor Young.
Graduate Students: Tram Nguyen and Young Ha Suh from the Cornell Lab of Ornithology who aided in the digitisation of bird specimens.
Nancy Deyrup is a volunteer in the entomology program who singlehandedly digitised the majority of the insect-flower database. Dr Butch Norden, volunteer, organised the amphibian and reptile collection for digitisation.

BIO

Hilary Swain has been the Executive Director of Archbold since 1995, directing activities at Archbold Biological Station and the MacArthur Agro-ecology Research Center (MAERC). She works with a staff of 50 involved in long-term research, environmental monitoring, science education for students and the public.

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