

Duke's herbarium merits continued enhancement, not dissolution

Barbara Thiers , Trina E. Roberts , Rebecca J. Rundell , Garth M. Spellman , Gunter A. Fischer , Gil Nelson , John Bates , Scott V. Edwards , Emily B. Sessa , Jennifer M. Zaspel  and Jyotsna L. Pandey 

Barbara Thiers is affiliated with the New York Botanical Garden, in the Bronx, New York, in the United States. Trina E. Roberts is affiliated with the Natural History Museum of Los Angeles County, in Los Angeles, California, in the United States. Rebecca J. Rundell is affiliated with the State University of New York College of Environmental Science and Forestry, in Syracuse, New York, in the United States. Garth M. Spellman is affiliated with the Denver Museum of Nature and Science, in Denver, Colorado, in the United States. Gunter A. Fischer is affiliated with the Missouri Botanical Garden, in St. Louis, Missouri, in the United States. Gil Nelson is affiliated with iDigBio, at the Florida Museum of Natural History, at the University of Florida, in Gainesville, Florida, in the United States. John Bates is affiliated with the Negaunee Integrative Research Center, at the Field Museum, in Chicago, Illinois, in the United States. Scott V. Edwards is affiliated with the Museum of Comparative Zoology and with the Department of Organismic and Evolutionary Biology at Harvard University, in Cambridge, Massachusetts, in the United States. Emily B. Sessa is affiliated with the New York Botanical Garden, in the Bronx, New York, in the United States. Jennifer M. Zaspel is affiliated with the Milwaukee Public Museum, in Milwaukee, Wisconsin, in the United States. Jyotsna L. Pandey is affiliated with the American Institute of Biological Sciences, in Herndon, Virginia, in the United States.

Natural history collections form the foundation of a comprehensive biodiversity infrastructure that supports research on the natural world. Like libraries, they provide extensive, documented, accessible reference material, a stable place for the permanent deposition of voucher material used in published research, and an archive of changing biodiversity. Natural history collections of plants—herbaria—have supported botanical scholarship for centuries.

The Duke University Herbarium is the largest herbarium in the southeastern United States, the most biodiverse region of the country. It holds 825,000 specimens of algae, bryophytes, fungi, and vascular plants that have been collected over the past 100 years. Highlights include vascular plants of the southeastern United States and tropical America; one of the largest bryophyte collections in the country, emphasizing peat mosses, the cornerstone of many wetland ecosystems; substantial collections of fungi, including lichens; and marine algae documenting southeastern seaweed diversity (Duke University 2024a).

Duke University no longer considers the herbarium to be an educational or research priority. The five Department of Biology faculty most closely associated with the herbarium were instructed to find new homes for the collection within the next 2 to 3 years. The university has not suggested a mechanism for carrying out their edict; nor have they offered logistical or financial support for the herbarium's disbursement (Kathleen Pryer, Duke University, Durham, North Carolina, United States, personal communication, 13 February 2024). Duke is the largest herbarium to be divested from its founding institution in US history; the largest previous divestment was the University of Louisiana, at Monroe's herbarium and fish collections, in 2016 (Bolden 2017).

As members of the Natural Science Collections Alliance Board of Directors, we understand that maintaining a biological collection of the size and stature of the Duke University Herbarium requires significant resources. Proper collection care requires ongoing investment in physical and digital infrastructure, staff training and professional development, and educational and outreach programs (NASEM 2020). Over time, many institutions have con-

cluded that they can no longer support their biological collections and have found others willing to accept this shared responsibility.

However, the proposed Duke Herbarium divestment causes unprecedented concern for several reasons. The herbarium is a key asset for addressing our planet's global environmental challenges and for providing a holistic, twenty-first century education for Duke's students. The sheer size of the Duke Herbarium and the effort and expense that will be required to relocate it will have a negative impact on other US biological collections, burdening them with the cost of absorbing these collections and distracting them from their own research and educational agendas. The extraordinary nature of Duke's decision is reflected in the shock and dismay with which it was met by natural science leaders around the world and by Duke's own community. Articles in Duke's student-run newspaper and in national media, along with an online petition and letters of protest from numerous professional societies and individuals, have shown the breadth of negative reactions.

The perception by Duke's leadership that biological collections are not an academic priority runs counter to current national and international trends. There are approximately 3600 herbaria worldwide. In the past five years, 345 new herbaria have been recognized (63 of these in the United States), whereas only 53 herbaria have closed (8 in the United States; NYBG Steere Herbarium 2024). The National Academies of Science, Engineering, and Medicine reaffirmed the value of the nation's legacy of biological collections for research and education (NASEM 2020). Support for collections and their public access has been a National Science Foundation (NSF) funding priority. For example, the NSF invested \$100 million in US herbaria and museum collection digitization between 2010 and 2021 (NSF 2015). Increasing access to the nation's heritage of species occurrence data through digitization has opened the door to large-scale analyses of changes in species distribution and phenology. The concurrent refinement of tools for extracting genomic data from specimens has provided deep insights into speciation and the evolution of species characteristics. The NSF is currently funding the Biodiversity Collections Network (BCoN) and the American Institute of Biological Sciences (award

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no. 2,303,588) to explore ways to link digitized specimen records to ecological, environmental, genetic, and public health data sources to enable new insights into conserving biodiversity and accelerate scientific discovery and innovation (BCoN 2024). The scientific advances that have accrued in recent years from herbarium specimens and their derivative data have been summarized by many authors (e.g., Folk et al. 2021, Davis 2023).

Discontinuing the Duke Herbarium and the research associated with it harms the educational capacity of the university. As plant species decline and habitats are removed or degraded, herbaria are centers for teaching students what was (e.g., through baseline data from physical specimens) and what could be (e.g., the potential effects of climate change or the possibility of habitat and species restoration). Without an herbarium, Duke students are unlikely to learn basic skills of species identification and occurrence documentation and will not become familiar with the ever-growing body of techniques for discovering data within the legacy of preserved specimens. Closing the Duke Herbarium therefore erodes the expertise needed to solve our nation's growing environmental challenges.

The loss of the herbarium and related research programs will reduce funding opportunities for the university and will lessen the probability of funding for other Duke programs. The researchers and students associated with the herbarium have secured an excess of \$30 million in external research funds since 2001. The herbarium itself has received funding from the NSF for facility upgrades and more than \$3 million in funds for specimen digitization. Ironically, the most recent grant obtained for the Duke Herbarium is for the incorporation of the collections of *Sphagnum* (peat moss) from the State University of New York at Binghamton (award no. 2,152,585, \$250,000, currently active). The abdication of the responsibility for the herbarium despite federal investments to strengthen and support it presents challenges for other Duke collections or programs seeking infrastructure funding in the future.

Duke's abandonment of its herbarium negatively impacts other US biological collections and research communities. Given the size of Duke's herbarium, it is unlikely that any other collections institution in the country could fully fund the move and rehousing of these collections, especially within the university's stipulated timeline. Therefore, the financial burden for this work will likely fall on the public. The most modest recent herbarium-related grant from the NSF's program for the transfer and incorporation of orphaned specimens was funded at approximately \$10 per specimen. Therefore, the minimum grant support needed for rehousing the Duke specimens is more than \$8 million—half of the annual budget for this NSF program, which is intended to advance 40–60 new and continuing projects per year (NSF 2023).

Rehousing poses risks for a collection that are proportional to its size. A collection the size of Duke's may sit in storage while new facilities are prepared for it. Storage outside of a proper collection facility raises the possibility of damage from insects and fungi, to which herbarium specimens are extremely susceptible. Relocations of this magnitude are also prone to human error, increasing the likelihood for specimen and data loss. If collections or related data are inaccessible or lost, they are unavailable to researchers

and students, encumbering plant research productivity in one of the most biodiverse and agriculturally significant regions of the United States. Duke's declaration that it will no longer maintain its own herbarium is tantamount to shirking its role in the shared responsibility of our country's unparalleled biodiversity resources.

We urge Duke to reconsider its plans to close its herbarium and disperse its collections. As a leader in biodiversity sciences, Duke should do this for its own benefit and to prevent burdening other institutions and the public with the cost of moving and curating Duke's collections. To ensure a transparent decision-making process, Duke should convene a group of internal and external experts and potential funders to discuss the future of the collections, including potential partnerships with other regional entities. The goal should be to create a plan for the herbarium that will ensure its continuing contribution to preserving biodiversity and functioning ecosystems. Duke must consider continuing support for their herbarium as an embodiment of their stated goal to “accept our responsibilities to one another—to think and act in ways that are ethical, legal, and just and that demonstrate courage, compassion, service, accountability, and commitment in all we do on behalf of Duke” (Duke University 2024b).

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