

State of the World's Herbaria

Subjects: Biodiversity Conservation

Contributor: Barbara M. Thiers

Herbaria remain the primary means of documenting plant life on earth, and the number of herbaria worldwide and the number of specimens they hold continues to grow. Digitization of herbarium specimens, though far from complete, has increased the discoverability of herbarium holdings and has increased the range of studies from which data from herbarium specimens can be used. The rather large number of herbaria about which no current information is available is a source of concern, as is herbarium consolidation and removal of herbaria to offsite storage facilities. Partnerships are key to the future health of herbaria.

Keywords: biological collections ; herbaria ; digitization ; historical collections ; museological importance

1. Introduction

An invention of Renaissance Europe, the herbarium has endured for five centuries as the primary means of documenting plant life and has spread to all corners of the earth. The most objective source of information on the current state of the world's herbarium is Index Herbariorum ^[1], which compiles information, provided by herbaria themselves, about the location, holdings and staff for each herbarium that chooses to register itself in the index. In this text, the term "herbarium" includes collections of fungi, which are sometimes referred to as fungaria, as well as algae, bryophytes, and lichens. Although Index Herbariorum began in the 1930s, a snapshot of the data has only been captured on an annual basis since 2016. According to the most recent annual report ^[2], as of 31 December 2022 there are 3567 active herbaria in the world, containing 396,746,986 specimens. Associated with the world's herbaria are 13,717 staff members and associates. Ninety three percent of the world's countries have at least one herbarium. Since 2016, the number of registered herbaria has increased by 605, and 92 herbaria have been reported as inactive. During this period, the number of specimens reported by the world's herbaria has increased by more than 15 million specimens and the number of associated staff by approximately 2100.

2. The Current State of the World's Herbaria

Positive trends for herbaria

Beginning in the 1990s, but increasing in intensity from about 2010 until today, herbarium specimen digitization has provided one of the most significant advances in the history of herbaria ^{[3][4][5]}. Although digitization originally referred only to the transcription of specimen label data into a structured database, now digitization routinely involves capturing a digital image of the specimen as well, a procedure for which, due to their flat shape, herbarium specimens are particularly well suited.

Digitized herbarium specimen data are aggregated and shared through several data portals. These portals may be international, such as the Global Biodiversity Information Facility [GBIF] or iDigBio data portals ^{[6][7]}; geographically based, such as those for herbarium specimens from Australia ^[8], Brazil ^[9], China ^[10] Colombia ^[11] and Mexico ^[12]; or taxon-based portals for fungi ^[13], ferns and related groups ^[14], and fungi ^[15]. Often, datasets in the "specialty" portals are also served to GBIF and iDigBio. The number of herbarium specimens available online through GBIF as of 14 November 2023 is 231,562,216, constituting 58% of the specimen total reported in Index Herbariorum.

Digitization and the open sharing of data on worldwide data portals has made it possible for herbaria to greatly extend their reach, and it has been an especially important way for researchers in formerly colonized countries to gain access to specimens that were collected during colonial-era expeditions ^[16]. The new research uses of herbarium specimens to gain a deeper understanding of plant biodiversity are ably summarized by several authors ^{[17][18][19][20]}. Herbarium specimen data have helped to identify the species most at risk of extinction ^{[21][22][23]}, why species become invasive ^[24], and how relationships between plants and the animals that pollinate and predate them have changed over time and may change in

the future ^{[25][26]}. Curricula and lesson plans compiled through projects such as Biodiversity Literacy for Undergraduate Education ^[27] demonstrate how digitized herbarium specimens can be used to teach data literacy.

Negative trends for herbaria

Despite the success of herbarium digitization, the perception remains that the herbarium enterprise is in peril, as posited in articles such as that of Deng ^[28]. The herbarium decline cited in this article was evidenced by several highly publicized herbarium closures in the U.S., i.e., the University of Missouri at Columbia and the Brooklyn Botanical Garden in New York City in 2015 ^{[29][30]}, and the University of Louisiana at Monroe in 2017 ^[31]. In all these cases, other herbaria absorbed the specimens from those that closed, so there was no loss of specimens.

Although worldwide decline in herbaria is not supported by a decrease in the number of active herbaria, there are many herbaria for which we have no recent data. Despite repeated efforts to encourage them to do so, nearly 800 herbaria have not updated their contact or other information for Index Herbariorum in more than 15 years. It is possible that some of these herbaria no longer exist, or have no one actively managing the collection, and thus the collections they hold (approximately 25 million specimens in total) may be lost or in peril.

In recent years, several prominent institutions have made the decision to move their herbarium from a location central to their administrative functions to a more remote location. The University of Michigan Herbarium (Index Herbariorum code MICH) was moved from the central campus to a location seven km from central campus in 2002. In 2022, the Sydney Botanic Gardens herbarium (NSW) was moved from the main grounds of the Royal Botanic Gardens Sydney near Sydney Harbor to Mt. Annan, New South Wales, 59 km away. In 2023, the Royal Botanic Gardens, Kew, announced plans to move the herbarium (K), the second largest in the world, to a new facility at the Thames Valley Science Park in Reading, approximately 57 km from the Botanic Gardens' main grounds in Richmond. In the case of MICH and NSW, the new quarters provided ample well-configured space for maintaining current herbarium functions, allowing for the possibility of expansion of those functions. Plans announced for the new Kew herbarium facility suggest that the new facility would likewise be designed to enhance and expand current herbarium functions ^[32]. However, relocating a collection from a prominent location within an institution to a remote one causes fear that the herbarium will become marginalized administratively (especially budgetarily) as well as physically. Removing the herbarium from the center of the institution is seen as symbolic of a belief by the institution's leadership that herbarium is not central to the institution's mission. Such a move may also complicate work travel for staff and in-person visits to the collection ^{[33][34]}. However, in many cases, the herbarium's facilities may be significantly upgraded through the move and the institution can point to the major new financial investment for the new facility as a commitment to the value of the collection rather than an indication of marginalization. Given that most of these relocations are relatively recent (or in the case of Kew, only planned), it is not possible yet to make any objective measure of impact of relocation on the ability of the herbarium to fulfill its mission.

Challenges facing herbaria in the 21st century

Herbaria hold data that are key to understanding how earth's vegetation has changed over time, and how it may change in the future, an issue of critical importance for everyone on the planet. Given the urgency of these issues, it can be argued that herbaria have never been more relevant for humanity. Whether or not the herbarium enterprise will grow and flourish over the next century or be increasingly marginalized from mainstream science will depend on how active a role those responsible for the care of the world's herbaria are willing to play in demonstrating that relevance. The conundrum of how to take on additional roles at a time when some herbaria resources are in decline and existing staff are already stretched to the limit may be solved, at least in part, by the creation of new partnerships or reimaging of existing ones, and perhaps adjusting priorities and former measures of success.

References

1. Thiers, B.M. Index Herbariorum. Available online: <https://sweetgum.nybg.org/science/ih/> (accessed on 4 December 2023).
2. Thiers, B.M. The World's Herbaria 2016–2022. Available online: <https://sweetgum.nybg.org/science/ih/> (accessed on 4 December 2023).
3. Soltis, P. Digitization of herbarium specimens enables novel research. *Am. J. Bot.* 2017, 104, 1281–1284.
4. Cantrill, D. The Australasian Virtual Herbarium: Tracking data usage and benefits for biological collections. *Appl. Plant Sci.* 2018, 6, e1026.

5. Hedrick, B.P.; Heberling, J.M.; Meineke, E.; Turner, K.G.; Grassa, C.J.; Park, D.S.; Kennedy, J.; Clarke, J.A.; Cook, J.A.; Blackburn, D.C.; et al. Digitization and the future of natural history collections. *Bioscience* 2020, 70, 243–251.
6. Global Biodiversity Information Facility. Available online: <https://www.gbif.org/> (accessed on 4 December 2023).
7. iDigBio. Available online: <https://www.idigbio.org/> (accessed on 4 December 2023).
8. The Australian Virtual Herbarium. Available online: <https://avh.chah.org.au/> (accessed on 4 December 2023).
9. SpeciesLink. Available online: <https://specieslink.net/> (accessed on 4 December 2023).
10. Chinese Virtual Herbarium. Available online: https://www.cvh.ac.cn/contact_us.php (accessed on 4 December 2023).
11. Triana. Available online: <http://biovirtual.unal.edu.co/triana> (accessed on 4 December 2023).
12. Comisión Nacional Para el Conocimiento y Uso de la Biodiversidad Data Portal (CONABIO). Available online: <http://www.conabio.gob.mx> (accessed on 4 December 2023).
13. MyCoPortal. Available online: <https://www.mycportal.org/portal/> (accessed on 4 December 2023).
14. Pteridophyte Collections Consortium. Available online: <https://www.pteridoportal.org/portal/index.php> (accessed on 4 December 2023).
15. Macroalgal Herbarium Consortium. Available online: <https://macroalgae.org/portal/> (accessed on 4 December 2023).
16. Drew, J.A.; Moreau, C.S.; Stiasny, M.L. Digitization of museum collections holds the potential to enhance researcher diversity. *Nat. Ecol. Evol.* 2017, 1, 1789–1790.
17. Heberling, J.M.; Prather, L.A.; Tonsor, S.J. The changing uses of herbarium data in an era of global change: An overview using automated content analysis. *BioScience* 2019, 69, 812–822.
18. Heberling, J.M.; Miller, J.T.; Noesgaard, D.; Weingart, S.B.; Schigel, D. Data integration enables global biodiversity synthesis. *Proc. Natl. Acad. Sci. USA* 2021, 118, e2018093118.
19. Willis, C.G.; Ellwood, E.R.; Primack, R.B.; Davis, C.C.; Pearson, K.D.; Gallinat, A.S.; Yost, J.M.; Nelson, G.; Mazer, S.J.; Rossington, N.L.; et al. Old Plants, New Tricks: Phenological Research Using Herbarium Specimens. *Trends Ecol. Evol.* 2017, 32, 531–546.
20. Ames, M.; Spooner, D.M. DNA from herbarium specimens settles a controversy about origins of the European potato. *Am. J. Bot.* 2008, 95, 252–257.
21. Willis, F.; Moat, J.; Paton, A. Defining a role for herbarium data in Red List assessments: A case study of *Plectranthus* from eastern and southern tropical Africa. *Biodivers. Conserv.* 2003, 12, 1537–1552.
22. Miller, J.S.; Porter-Morgan, H.A.; Stevens, H.; Boom, B.; Krupnick, G.A.; Acevedo-Rodríguez, P.; Fleming, J.; Gensler, M. Addressing target two of the Global Strategy for Plant Conservation by rapidly identifying plants at risk. *Biodivers. Conserv.* 2012, 21, 1877–1887.
23. Nic Lughadha, E.N.; Walker, B.E.; Canteiro, C.; Chadburn, H.; Davis, A.P.; Hargreaves, S.; Lucas, E.J.; Schuiteman, A.; Williams, E.; Bachman, S.P. The use and misuse of herbarium specimens in evaluating plant extinction risks. *Philos. Trans. R. Soc. Lond. Biol. Sci.* 2019, 374, 20170402.
24. Meinecke, E.K.; Classen, A.T.; Sanders, N.J.; Davies, T.J. Herbarium specimens reveal increasing herbivory over the past century. *J. Ecol.* 2019, 107, 105–117.
25. Novak, S.; Mack, R.N. Tracing plant introduction and spread: Genetic evidence from *Bromus tectorum* (Cheatgrass). *Bioscience* 2001, 51, 114–122.
26. Calinger, K.M.; Queenborough, S.; Curtis, P.S. Herbarium specimens reveal the footprint of climate change on flowering trends across north-central North America. *Ecol. Lett.* 2013, 16, 1037–1044.
27. Biodiversity Literacy in Undergraduate Education. Available online: <https://www.biodiversityliteracy.com/> (accessed on 4 December 2023).
28. Deng, B. Plant collections get pruned back. *Nature* 2015, 523, 16.
29. Thiers, B.M. Index Herbariorum Record for University of Missouri. Available online: <https://sweetgum.nybg.org/science/ih/herbarium-details/?irn=126715> (accessed on 4 December 2023).
30. Foderaro, L.W. Brooklyn Botanic Garden Defends Decision to Suspend Science Program. *New York Times*. 22 September 2013, p. 18. Available online: <https://www.nytimes.com/2013/09/23/nyregion/brooklyn-botanic-garden-defends-decision-to-suspend-science-program.html> (accessed on 4 December 2023).
31. Safe: ULM Natural History Collections to go to Universities from Mississippi to Texas. *The News Star*. 28 June 2017. Available online: <https://www.thenewsstar.com/story/news/education/2017/06/28/safe-uhl-natural-history-collections-go-universities-mississippi-texas/436901001/> (accessed on 4 December 2023).

32. Relocating Kew's Herbarium for the Future of Our Collections. Royal Botanic Gardens Kew Website. Available online: <https://www.kew.org/read-and-watch/relocating-kews-herbarium> (accessed on 4 December 2023).
 33. Backlash over Kew Gardens Plan to Move 7 m Plant Specimens. London Times. 19 October 2023. Available online: <https://www.thetimes.co.uk/article/kew-gardens-under-fire-over-relocation-of-7-million-plant-specimens-pvcg5zznz> (accessed on 4 December 2023).
 34. Stokstad, E. Botanists fight removal of plant specimens from one of the world's most spectacular gardens. *Science* 2023, 38, 138–139.
-

Retrieved from <https://encyclopedia.pub/entry/history/show/120958>