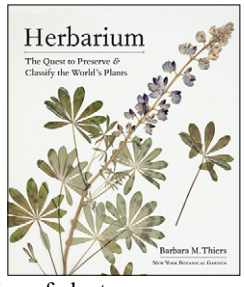
Herbarium: The Quest to Preserve & Classify the World's Plants

By Barbara M. Thiers. 2020. Timber Press. 304 pages, 40.00 USD, Cloth, 30.05 USD, E-book.



An herbarium is simply a collection of dried plants. They may be glued into a book or mounted after flattening onto separate sheets of light cardboard with labels. They have been, and still are, especially useful, let us say absolutely essential, to the processes of identification and classification of plants.

In the Preface Dr. Theirs, Director of the William and Lynda Steere Herbarium of the New York Botanical Garden, notes that she was impressed that formal botanical training in the mid- to late-20th century included so little in the way of background about herbaria. We are now well into the 21st century and not much has changed in this respect. Thiers further notes:

> At a time when we seem to be bombarded daily by negative aspects of human nature, herbaria highlight one of our better human impulses: to save things for the future, not just for ourselves but for generations to come … As much as our modern lives tend to separate us from the rest of earth's biodiversity, we cannot exist without it, and these preserved organisms give us information about our world and clues to its future that we cannot learn any other way. (p. 11)

Thiers is kindly apologetic about focussing attention on herbaria in Europe and the United States, and hopes that the stories of herbaria in other countries will be written. In Canada we have the nineth largest herbarium in North America (acronym DAO, at Agriculture and Agri-Food Canada in Ottawa) with over 1.55 million specimens. It is the 43rd largest collection in the world (Thiers 2021b: 8). I had the great pleasure of serving as Chief Curator of this remarkable collection for several decades. Perhaps, with the encouragement from Thiers, the story of this and many other Canadian herbaria will be told. I hope that Thiers does not worry too much about what was left out. It is a very large subject that she treated remarkably well. The challenge is there for any of us to expand a chapter or a section into another book.

This book contains five chapters. To give the reader a better idea of the content, I have paraphrased some of the fascinating information provided by Theirs, sometimes adding a little of my own with references that can be pursued further.

The Origin of Herbaria draws attention to some of the first herbaria. Botany was once a minor subdiscipline of medicine, but the development of herbaria allowed the study of plant classification and evolution to become a separate endeavour. It is suggested that herbaria may have developed in Europe earlier because the longer winter season when plants were not available for observation made a dry collection particularly advantageous and the flourish of science, new ideas, and innovations during the Renaissance brought the herbarium with it. Italian physician Luca Ghini created the first herbarium in the early 1500s, and the herbaria of his students exist to this day. As well as the origins of vascular plant collections, Thiers considers the origin of cryptogamic collections.

In Herbaria and the Age of Botanical Exploration, Thiers explains that in the 18th and 19th centuries many European countries undertook explorations around the world to obtain materials for trade, some of which were plant derived, including spices, drugs, food, and horticultural plants. As this became more popular and the need to know more about plants increased, collecting specimens and putting them in herbaria also increased.

The stories that are part of this period are very entertaining, some written by the plant collectors themselves. William Drapier was the first to be charged with collecting herbarium specimens. He was a pirate (a privateer in the proper British vocabulary of the time) working for the Royal Navy. He wrote a book published in 1697 that became very popular with the public. This led to a position with the Royal Navy as a botanical explorer. Unfortunately, he "went south". His ship sank but some of his specimens and his notes were saved. When he returned to England he was court-martialed and retired as a pirate. His specimens and notes, however, lived on and were used by later explorers, including Banks, Humboldt, Darwin, and Wallace (also discussed in this chapter).

During this time, women, disguised as sea-faring men, illegally joined exploratory expeditions. Some of them (perhaps all) were smarter than men, worked harder than men, and became more well known for their contributions to botany. Jeanne Baret, aka "Jean", had *Solanum baretiae* named in her honour and received a pension from the French navy in 1785. *Ce n'est pas une surprise, … juste un fait intéressant.* I cannot remember the name of her male colleague.

The difficulties, sacrifices, labours, dangers, and costs of building plant collections in those early times are hard to imagine. Many plant collectors died, were wounded, or sickened and never completely recovered; plant science suffered huge tragedies. In a concluding section on later development, we learn about

the destruction by Allied bombing on 1 March 1943 during World War II of the Berlin Herbarium (Herbarium Berolinense, acronym B). Fortunately, the herbarium of Carl Ludwig Willdenow, the founder of Phytogeography, as well as 20 000 types of specimens had been recently moved out to off-site storage in a protective mine shaft. Three and one half million specimens were destroyed, including 30 000 specimens on loan from other herbaria. Considering the remarkable effort to create the Berlin Herbarium, founded in 1815 (Hiepko 1987: 1), and its potential for future contributions to science, this was a "a catastrophe of major proportions to world botany" (Merrill 1943: 490), although a minor event in the many tragedies of that war. What was lost was priceless and irreplaceable world heritage, but luckily photographs of 40 000 specimens, including many destroyed, were obtained in 1929 by the Field Museum in Chicago. The Berlin Herbarium was rebuilt and restored to its former accession level by 1979, with help from around the world. For much more information on Herbarium Berolinense, see Hiepko (1987).

In Development of Herbaria in the United States, I particularly liked Thiers's text on the French scholar, Constantine Samuel Rafinesque. It is kind, balanced, and informative, perhaps the best I have read about this unreliable and erratic figure. It seems that all groups possess destructive forces. Rafinesque was the destructive force in North American classification of flora and fauna. He was desperate to name (not describe) new species. There is sometimes a humorous side. We have heard people say "you have to laugh … or you'll cry". There is the story of how he broke Audubon's violin trying to knock down a new species of bat (everything was a new species to him). This lack of sensitivity upset Audubon, who subsequently supplied Rafinesque with a series of sketches of mammals (all imaginary) that Rafinesque promptly named. He even named some of these imaginary mammals accidentally twice (using different names of course)!

One does not have to be an herbarium practitioner to find interesting information here. Alice Eastwood, who did so much to document the flora of California, was born in Toronto. She made the California Academy of Science Herbarium the most complete record of western plant life. She became well known for her heroic efforts to protect the herbarium during the San Francisco earthquake in 1906. She was there because The California Academy of Sciences was one of the first institutions in the world to recognize and encourage women scientists.

With his large personal herbarium of 100 000 species, George Engelmann began the herbarium of the Missouri Botanical Garden. With his extensive herbarium-based knowledge of plants, and his special interest in grapes, he saved the French grape industry by providing a North American rootstock, resistant to a damaging pest. These are just a few of the interesting stories of herbaria. This fascinating chapter concludes with a valuable overview of herbarium digitization, the exciting interface of plant collections and modern computerized analysis.

In Development of Herbaria Around the World we learn that many of the stories about the development of herbaria around the rest of the world are similar to those of Europe and the United States, but they are also unique in a number of ways because they took on the flavour of the country. After Joseph Banks made such a valuable contribution to the study of Australian botany through the collection of herbarium specimens, Linnaeus wanted Australia to be named "Banksia". Prisons were popular in England at the time, and Banks suggested that Australia could be used as a penal colony to reduce overcrowding in England. People were unlikely to come back in those days! A penal colony was established in the botanical paradise of Botany Bay in 1788. The city of Sydney grew up nearby, but luckily some of the remarkable landscape was protected in Kamay Botany Bay National Park.

A recurrent theme is the fluctuating good times and bad times which changed with the political climate. Following the Boxer Rebellion in 1901, China had to pay foreign powers for losses. However, the United States allowed money paid to them to be used to assist Chinese students to come to the United States for advanced studies. Many of these students went back to China to build significant herbaria and did valuable work on Chinese biodiversity, at least for a while. A cultural revolution in China beginning in 1966 halted scientific research and prominent botanists were starved, beaten, and forced to write confessions, and some were lost. The light at the end of the tunnel was reached in the mid 1970s and Chinese herbaria again began to grow with associated large contributions to botanical science.

There was a tendency for Chinese research to be relocated further south during World War II to avoid Japanese occupation. This brought Chinese scholars into under-explored territory in Hubei province and this led to the discovery of living trees of Dawn Redwood (*Metasequoia glyptostoboides*). The plant had been known as a fossil since 1941, but by 1948 seeds from a limited region of China had been sent around the world, thus ensuring its preservation. This living fossil can be seen in several Canadian botanical gardens, and there are other similar examples, also from China. This chapter also contains sections on the development of herbaria in Brazil and South Africa.

The Future of Herbaria stresses that herbaria are vast storehouses of information that is available directly and also through analysis. They have been used to study and predict: harmful heavy metals in the environment; atmospheric conditions; distributions, tolerances, and productivity of plants; the changing timing of important events; the spread of pathogens and invasives; and to facilitate conservation and protection. (In addition to the text and references provided by Thiers, the reader may find useful information on the value of herbaria in references provided below, including: Prather *et al.* 2004; Nualert *et al.* 2007; Ellis 2008; Bebber *et al.* 2010; Mitrow and Catling 2011; Eisenman *et al.* 2012; Culley 2013; Guerin 2013; Lavoie 2013; Kuzima *et al.* 2017).

A section on educational opportunities in herbaria explains that "plant blindness" (p. 232) is the phenomenon wherein we see plants not as living organisms that are key to our existence but merely as background scenery to our lives. A section on threats to herbaria suggests (very correctly) that a major threat is misperception that herbaria are part of the past descriptive science rather than the future unified science. As a result of the late 20th century shift to interest in subcellular processes, funding declined for biodiversity research. Actually, herbaria play a huge role in modern molecular science, but "we are still in a period where general impressions of value lag behind reality, and many herbaria lack sufficient infrastructure and basic curatorial staff" (p. 239). However, the situation is changing. The US National Science Foundation has commissioned a study by the National Academy of Sciences to recommend a strategy to safeguard and sustain these irreplaceable research and educational resources.

> Publications using herbarium data have increased exponentially over the last century. As we enter the Anthropocene, herbaria have likewise entered a new era with enhanced scientific, educational, and societal relevance. (Heberling *et al.* 2019: 812)

This chapter concludes with a section entitled How You Can Help. It reminded me of a time when we arranged with a group of disabled people to mount plants in their homes and to come into the herbarium prep room to do similar mounting and recording work. It was unbelievably successful, as was another volunteer program which attracted the attention and awards from upper management, providing a valuable opportunity to explain herbarium value.

A more specific and interesting application of community science to increase the value of herbarium specimens was recently described by Heberling and Isaac (2018). It involves associating photographs in iNaturalist with QR (quick response) codes on herbarium specimen labels (produced in iNaturalist) which can be read by smartphones and tablets to enable immediate access to field images, a mapped location, and other information. The label data are also stored in appropriate databases in Darwin Core format. This procedure takes advantage of the fact that very good quality photographs are much easier to obtain now than in the past. There is still a great deal of work to do, and millions of specimens are needed by herbaria. This means that community science help in collecting the best specimens that we have ever had is very important and exciting.

One of the basic tools for herbarium researchers and staff over decades has been Index Herbariorum (Thiers 2021a), produced since 1935 by the New York Botanical Garden. It is a guide to the herbaria of the world, providing addresses, staff and specialties, contents, and other details. The most recent iteration of this very valuable work is that of Thiers (2021b). Her book reviewed here is like a companion to Index Herbariorum that gives an idea of how herbaria came to be, of their great importance, the character of the people involved, their remarkable contributions, and the whereabouts of their specimens. This makes it a very important reference. It is so well written that it serves also as a source that can be enjoyed by the public and provides a compelling record of botanical science for anyone just looking for a good read.

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