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THE HERBARIUM

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INTRODUCTION

We use the term herbarium in three ways. At first, it was a book on medicinal plants. This use of the term can be found in the writings of Pliny the Elder (A. D. 23-79). Later the word came to mean a set of specimens that had been pressed and dried, and typically bound together to form a book. Since the late 1500's, a third usage became common -- an herbarium was a case, or a room, or a building that houses a collection of pressed and dried plants, arranged systematically. In other words, the term herbarium has been applied to a book, to a set of pressed and dried plants, and to the place where these specimens are housed.

According to Agnes Arber in her 1938 treatise on herbals, Luca Ghini (1490?-1556) was the first person to dry plants under pressure, mount them on paper, and store them as a permanent record. He was a Professor of Botany at the University of Bologna, in Italy. The practice of preparing herbarium specimens, depositing them in permanent repositories, and exchanging duplicates among collections was well established by the time of Linnaeus (1707-1778).

THE FIVE OLDEST HERBARIA*

Herbarium	Number of Specimens
Naturkundemuseum (Kassel) (1569)*	30,000
Università di Bologna (1570)	130,000
Universität Basel (1588)	220,000
University of Oxford (1621)	375,000
Muséum Nat. d'Hist. Nat. (1635)	8,000,000

* Date founded

There are now 2962 herbaria in 176 countries. They hold 381,308,064 specimens. The 641 herbaria in the United States contain 76,101,221 of them (Thiers 2016).

THE TEN LARGEST HERBARIA*

Herbarium	Number of Specimens
Muséum National d'Historie Naturelle	8,000,000
New York Botanical Garden	7,800,000
Komarov Botanical Institute	7,100,000
Royal Botanic Gardens	7,000,000
Naturalis (Netherlands)	6,900,000
Missouri Botanical Garden	6,000,000
Conservatoire et Jardin Botaniques de la Ville de Genève	6,000,000
Naturhistorische Museum Wien	5,500,000
Natural History Museum (London)	5,200,000
Harvard University	5,005,000

THE TEN LARGEST IN THE UNITED STATES*

Herbarium	Number of Specimens
New York Botanical Garden	7,800,000
Missouri Botanical Garden	6,000,000
Harvard University	5,005,000
United States National Herbarium	5,000,000
Field Museum of Natural History	2,700,000
University of California, Berkeley	2,100,000
California Academy of Sciences	2,000,000
University of Michigan	1,750,000
Academy of Natural Sciences	1,430,000
Rancho Santa Ana Botanic Garden	1,183,000

THE TEN LARGEST IN CALIFORNIA*

Herbarium	Number of Specimens
University of California	2,100,000
California Academy of Sciences	2,000,000
Rancho Santa Ana Botanic Garden	1,183,000
University of California, Davis	300,000
University of California, Los Angeles	190,000
San Diego Natural History Museum	150,000
Santa Barbara Botanic Garden	150,000
San Francisco State University	140,000
Humboldt State University	132,000
CSU, Chico	106,000

*Data from 2016 Index Herbariorum Annual Report.

WHAT ARE THE FUNCTIONS OF AN HERBARIUM?

Today's herbaria have a variety of functions. They include:

- preservation of specimens that have been the basis of scientific work (floras, monographs, theses, and various anatomical, cytological, chemical, genetic studies);
- documenting the occurrence of plants, from the rarest to the most common, at a particular site;
- documenting the diversity, variation, and distribution of plants;
- providing specimens that may be used to verify the identification of unknown plants;
- providing specimens that may be used to carry out further taxonomic research;
- providing more current scientific names of plants than those found in the floras of a region, which tend to be soon out-of-date;
- aiding in the instruction of students who use the specimens for review and as the basis of independent study projects;
- providing plant identifications as a public service;
- serving as a source of taxonomic and botanical information, through staff expertise and its associated reference collections;
- serving as the basis of future botanical research by providing plant specimens that can be subjected to further anatomical, chemical, numerical, and genetic investigation.

THE VASCULAR PLANT HERBARIUM

Today's herbarium is typically a room or an entire building containing metal storage cabinets (herbarium cases) filled with pressed, dried, and mounted specimens. The traditional herbarium case is either full-height or half-height with tight-fitting, hinged doors. More recently some of the larger herbaria have begun using compactor units. These are door-less storage units that move on tracks embedded in the herbarium floor. Access to the specimens is gained by a mechanism (human-powered gears or electricity) that separates the units from one another, thereby creating an aisle. Compactors have the advantage of allowing more specimens to be housed in a particular area because there is no need to set aside space for aisles. The herbarium at the California Academy of Sciences uses compactors to hold its main collection.

What Is an Herbarium Specimen? An herbarium specimen or herbarium sheet in its simplest terms is a piece of high quality paper with a plant and a label

glued or otherwise attached to it. The paper is heavy gauge, with a high fiber content, and acid-free surface. It is typically about 12" x 18." The plant material that constitutes a single specimen may be several small plants, one single plant, or only a portion of a plant. A label is usually glued in the lower right hand corner of the sheet. The herbarium typically stamps or otherwise identifies the specimen as part of its collection. You will often find the institutional accession number stamped on the sheet. This provides you with a means of citing that particular specimen. You may also find a small paper pocket or envelope, a fragment folder, attached to the sheet. Look inside for dissection material.

In the area above the label you will often find an annotation label. These are used when the original scientific name on the sheet must be corrected or updated. I particularly enjoy the handwritten annotations made by famous botanists. Their signature lets you know that they saw this very sheet! Sometimes the annotations may have been written directly on the herbarium paper, but that is not good practice. You may also encounter other subsidiary labels that indicate that this plant is a voucher specimen for a thesis, monograph, or other research project.

The specimen may also bear a label that tells you there is additional material that has been fixed or that bulky material (cones, large dry fruits, etc.) are stored separately.

How are Specimens Filed? Every herbarium that I have visited arranges its specimens initially by major plant groups -- ferns/fern allies, gymnosperms, or flowering plants -- and then by family. But how are the families arranged? When you use a university library, one the first thing that you need to know is whether the books are filed according to the Dewey Decimal System or using the classification developed by the Library of Congress. The same is true of herbaria. There is a tendency for the newer and smaller herbaria, such as ours, to put the families within each major group in alphabetical order.

The larger, older herbaria usually have their specimens filed according to the sequence of plant families developed by Engler and Prantl or Bentham and Hooker. In these systems, the families have been given numbers and the herbarium usually has these posted somewhere or put up in a notebook. When I was a student, we were expected to know the numbers of the major plant families according to Engler & Prantl. Such arcane knowledge is not common or expected these days. The logic behind this approach is that related families will be found next to one another in the herbarium. Even though these older systems do not reflect our current knowledge of phylogenetic relationships, they are maintained because the task of rearranging literally millions of specimens is overwhelming.

Whether the herbarium uses the alphabet or some phylogenetic system, knowing the family is essential. Then you will need to find out whether the curator uses Gramineae or Poaceae, etc. and whether the curator is a "lumper" or a "splitter"; does he/she, for instance,

recognize segregate families, such as Alliaceae, Convallariaceae, or go with a broader circumscription of Liliaceae. The HSU Herbarium has a list posted to assist you in this matter. Most herbaria do not.

Within a particular family, the herbarium specimens are usually arranged alphabetically by genus, and then by species, etc. They may be arranged according to the sequence in Engler & Prantl or even a particular monograph! Such herbaria are not very user-friendly. Within a given species, larger herbaria also tend to file their specimens geographically. Look for some color-coding or other indication on the specimen folders.

How to Handle Herbarium Specimens. The way to handle herbarium specimens is really not much more than glorified common sense. Just keep in mind that the specimens are fragile and should be treated carefully. If they are, they will last literally hundreds of years. Here are a few tips:

- Ask for a copy of any instructions that visitors are expected to observe.
- When removing a folder of specimens from an herbarium case, pull it straight out of the pigeon-hole, as opposed to pulling it downward over other folders or the shelf edge.
- If the herbarium allows you to refile specimens, you might consider slipping in a small tag to remind you where the folder belongs or pulling out the folder below the one you just removed.
- Do not keep a case door open any longer than needed. Make certain that the door is properly closed. Most herbarium cases have a 3-point locking mechanism and it is common for the top or bottom of the door to be a little tricky.
- Do not "tidy up" the specimens in a folder by holding it upright and striking one end on a table or counter top.
- Put the folder down on a flat surface, not on top of books or other paraphernalia.
- Do not put your pad of paper on top of specimens when you are making notes.
- As you work your way through a folder of specimens set each one aside to gain access to the next sheet. Always keep them face up. Never hold a folder of specimens and thumb through it as you would the pages of a book.
- Keep the specimens in the same sequence that you found them in the folder. There may not be any significance to it, but on the other hand the herbarium may be doing something subtle that has escaped your notice, such as filing its California specimens by county from north to south.
- Keep the specimens fully supported, especially when you are carrying them.

- Every "real" herbarium will have dissecting microscopes with the optical head on a long arm. This permits you to move the sheet around as needed. It is always a good idea to bring along your own hand lens.
- You will probably need to do some dissecting. Ask whether the herbarium has a softening agent that they want you to use. We use "Pohlstoffe" at HSU. It is made of 1% Aerosol OT (dioctyl sodium sulfosuccinate, a detergent; 74% distilled water; and 25% methyl alcohol. It is also great for cleaning your glasses.
- Never remove plant parts from an herbarium specimen without permission.
- Never remove old labels, including annotation labels. You would be tampering with the history of that specimen.
- The Curator will be grateful if you will point out present or past insect damage, specimens that need to be repaired, or what appear to be incorrect determinations, old names, and misfiled sheets. Most herbaria around the world are understaffed and the assistance of visitors is appreciated.
- Do not keep specimens out of the cases any longer than necessary. It only increases the chance of their being accidentally damaged. Exposure to sunlight can be harmful to some specimens.
- When you have finished looking at specimens, realign them in the folders so that none of the edges are sticking out and likely to get bent.
- Many herbaria are like libraries, in that you are not supposed to put the books back on the shelves, but place them in some designated area. If you are allowed to refile specimens, it is essential that you put them back exactly where you retrieved them – unless, of course, you think they were misfiled. Check with a staff member. Do not bend or force the folders as you put them back in a compartment.
- Clean up after yourself. Most of us curator-types are old fuddy-duddies who think that leaving a mess reflects badly on your upbringing.

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HERBARIUM CONSORTIA

California Herbaria: ucjeps.berkeley.edu/consortium

Intermountain Herbaria:
intermountainbiota.org/portal/collections/index

Midwest Herbaria: midwestherbaria.org

Mid-Atlantic Herbaria: midatlanticherbaria.org

Northeastern Herbaria: neherbaria.org

Pacific Northwest Herbaria: pnwherbaria.org

Regional Networks of North American Herbaria:
symbiota.org/docs/seinet

Texas Oklahoma Regional Consortium of Herbaria:
torcherbaria.org