Kathryn Kalmbach Herbarium

PLANT COLLECTION PROTOCOL

How to prepare herbarium specimens from the field to the herbarium cabinet
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WHY THIS GUIDE

This guide outlines the steps of how a plant in the field becomes a useful specimen to science. Its aim is to ensure the longevity and relevance of specimens (and the herbarium) beyond our time here at the Kathryn Kalmbach Herbarium of Vascular Plants (KHD) at the Denver Botanic Gardens.

Important components of a specimen at KHD include the plant, the herbarium label, the accession number (called the “herbarium number” in the database), and the barcode. The guide consists of several sections. Some sections provide specific how-to steps related to collecting plants for use as herbarium specimens. It also includes a tool list for the activities necessary in preparing herbarium specimens. Finally, the document provides general information about herbaria and the uses.

WHY WE COLLECT

Herbaria collections provide vital, scientific information that help us classify and better understand the living world. They inform our understanding of the scale and scope of our natural heritage. That, in turn, helps researchers and land managers to make educated decisions and to establish conservation priorities that are critical to our environment.

For many studies, the initial research begins at herbaria, where herbarium label information and the specimen itself can provide important information about the plant, such as when it flowers, whether it has a narrow distribution, or if it has specific habitat requirements. The plant itself can provide researchers with a search image prior to field work.

Our ability to conserve biodiversity would be hampered without these well-curated plant collections in which researchers consult. Scientists must first know the organism that they wish to protect before they can formulate a conservation plan. In essence, sound botanical research is specimen based.

As such, herbaria, and the millions of specimens they represent, are essential to scientists, teachers, and students, among others, as they approach their various scientific endeavors. The current uses of herbaria specimens are numerous and include, but are not limited to:

- plant identification / taxonomic studies
- phenologic research
- DNA or chromosomal studies
- alkaloid research
- pollination studies
- botanical illustration.

Natural history collections can provide essential information that leads to our understanding and, perhaps, our ability to protect our biodiversity. Thus, thoroughly documented, carefully collected, well curated, and painstakingly preserved specimens are essential to science. Just as botanists of the 1800s had no concept of current-day genetic studies, we do not know what the future uses of herbarium specimens may be. We can and must, nevertheless, ensure that plant specimens in our care will be here for years to come. The longevity of plant specimens that we seek begins with careful field collection and thoughtful practices.
Vouchering

Herbaria are storehouses of information that can help substantiate scientific studies. Research without specimens cannot be validated; validation is a fundamental step in the scientific process. Essentially, herbarium specimens are the lasting and irreplaceable historical records of where and when plants occurred. They attest to an area’s past and current biodiversity.

The process of vouchering herbarium specimens is one way in which herbaria, including KHD build their collections. Collections are also augmented by professional and amateur botanists, students, and volunteers who collect specimens in the course of their studies. In addition, plant collections grow through “exchanges,” or trading, with other herbaria.

The KHD is one arm of the Research and Conservation Department at the Denver Botanic Gardens. Our goal is to protect and conserve Colorado’s natural heritage. In that effort, Research and Conservation scientists help protect our natural history by:

- leading floristic studies
- monitoring plant populations
- conducting genetic studies
- documenting ethnobotanical uses of our native flora
- and collecting seeds and tissue from some of the state’s rarest plants.

The DBG research involves more than 100 rare and imperiled plants of Colorado. Our research team consults herbarium specimens prior to their field studies to familiarize themselves with the plant, acquire plant locations, learn about its phenologic characteristics, and inform themselves about the plant’s associated species and preferred geology. Researchers, when possible, collect voucher specimens of the plants they are studying.

Ethics

While it is important to document biodiversity and provide quality specimens for scientific study, we should never harvest a plant if doing so harms the overall population or environment we are trying to protect. Never collect a plant that is on the federal Threatened and Endangered Species List - there are 13 in Colorado - unless you have written permission.

In addition to the federally listed plants, the Colorado Natural Heritage Program tracks and ranks 173 rare and imperiled plants and habitats throughout the state. A complete list and explanation of the ranking system is located at http://www.cnhp.colostate.edu/about/heritage.asp. Do not collect plants that have a G1-to- G2 and S1-to-S2 ranking, unless you have a valid reason and permission to do so.

If at all possible, identify the plant before you harvest it. If you have any doubts about the plant’s status or ranking, and you are in an area or habitat that is known to support rare and imperiled plants, do not collect the plant. Instead, photograph the species, write detailed descriptions of the plant and the habitat, and record the location. If you must collect the plant, take only a fruiting or flowering stem, or enough material to identify it.

Aside from the listed and tracked plants, do not collect a plant unless it is part of a larger and viable population. A good rule of thumb is 1 in 20, which will also depend on the physiology of the plant. There are not limits on the number of weeds (non-native plants) that may be collected, especially noxious weeds, provided that doing so will not harm the larger landscape. Many weeds take advantage of disturbed ground and can quickly colonize a new area, so fill in the holes and divots you create during the collection process.
Wherever you plan to collect, you must have written permission. On government lands, you must keep your collecting permit with you at all times. Additionally, get written permission to collect on private lands.

Finally, make sure the plant you’ve collected will make a good herbarium specimen. See “What makes a good collection” section for more information.

**What makes a good collection**

A good collection relies on several important steps, including proper collecting and handling of the plant, recording thorough field notes, and thoughtfully processing the specimen.

First, a good collection begins with a meticulously collected plant. It should include, when possible and applicable, roots to shoots in good condition. This, of course, will not be possible with trees and shrubs or large, herbaceous plants. In such cases, cuttings are permissible provided detailed notes about the plant’s habit and size are included on the herbarium label.

The plant specimen also should contain diagnostic characters relevant to the identification of the particular species, genus or family in question. For example, with certain taxa it is important to collect mature fruits. In other taxa identification is based on flower color. In some cases, both fruits and flowers are necessary while in others, rooting systems such as rhizomes or taproots are important. A great deal depends on the taxon, so it is helpful to familiarize yourself with some of these features prior to going out into the field.

**COLLECTING**

Once you have decided on a location or project, it is important to be prepared both for collecting and for your personal comfort and safety. Below is a list of tools that you will need for collecting and a description on how to properly collect a plant for a herbarium specimen.

**Tools needed for the field:**

- a tool to unearth the plant - trowel, Hori Hori, etc.
- a GPS unit and/or maps
- sheets of newspapers
- Sharpie or marker
- notebook to record field notes, including pertinent information, such as flower color, description of plant, habitat, associated species, location, collectors, collection number, species name (if known) etc.
- dichotomous key for your area, e.g. Weber, Wingate, Dorn, etc.
- field press, if available, or use a telephone book
- several ventilators - cardboard sheets cut to size to fit in the field press and the wooden plant press
- herbarium blotters or several pieces of newspaper or cardboard to sandwich the plants in for drying
- wooden press with straps
Collecting the plant:

1. Before you remove the plant from the ground or water, record your location - UTM, TRS, or latitude/longitude - in your field notebook. Also, record habitat information, including associated plants, soil texture or type, substrate, etc. Also document information about the plant’s habit, flower color (if relevant), scent if it has one, and any information that may be lost when the plant is pressed and dried.

2. Using a digging tool, remove the plant, including roots, from the ground. Remove excess soil from plant, and clean the plant as best as you can. If there is a water source nearby, rinse the roots by shaking them in the water.

3. On your opened field press, take a sheet of newspaper and write your collection number, and the species name (if known) on the newspaper. Your serial collection number should correspond with collection number recorded in your field notebook (see Photos 1 & 2, above). Note: the newspaper should be approximately the same size as your field press or the size of an 11 x 18-inch herbarium sheet. Do not reuse newspapers.

4. Position the plant on the opened sheet of newspaper as it will appear as a specimen. If the plant is longer than the herbarium sheet fold it while ensuring that the plant will maintain its proper orientation. For example, the flower or inflorescence should be at the top of the herbarium sheet and the roots or rhizomes, ideally, should be at the bottom. In many cases this will require at least two folds of the plant (see Photo 3, right). In addition to proper orientation, the diagnostic features of the specific to the plant species should be visible. If the leaf surfaces - both abaxial and...
adaxial - differ, position the leaves so that both surfaces are visible. Once properly positioned, enclose the plant in the newspaper sleeve.

5. Sandwich the newspaper that contains the plant between two pieces of cardboard and close your field press. Your next collection will be placed on top of the previous collection. Each time place a sheet of cardboard on top of your last collection. Continue collecting in the same manner.

6. When you have finished collecting, transfer your specimens, still in the newspapers, to a wooden plant press. Because of movement and shifting during the collection process, you may need to readjust the plants within the newspaper sleeves to ensure proper pressing. Place one specimen at a time, still in its original newspaper sleeve, between two blotters or several pieces of newspaper to help absorb and wick away moisture. Continue to stack your specimens as if layering a sandwich. Periodically insert cardboard ventilators to help stabilize your press and to facilitate airflow. Cardboard ventilators should also be used to sandwich woody or bulkier specimens.

7. Using ropes or straps for this purpose, cinch the press as tightly as possible to ensure proper pressing and to help eliminate wrinkling of the plants.

8. Place the pressed plants in a hot, dry place or use an herbarium oven if one is available. After two days, replace the blotters and ventilators with dry ones, which will help prevent molding. Again, cinch the press as tightly as possible. Depending on the level of moisture in your specimens, you may have to replace blotters and ventilators every couple of days until your plants are dry. Loosely bundle the damp blotters and ventilators and place in a hot, dry place, or a herbarium oven, to dry before returning them to their storage area.

9. Check plants periodically to ensure they are not molding or that they are otherwise not damaged.

Writing your label

A good herbarium label can increase our knowledge of a geographic area. The label should contain the pertinent information about the plant and the habitat in which the species occurs.

Labels are typically typed using a word-processing program, such as Word. An easy to use template is available from KHD. The herbarium only accepts specimens with preprinted labels. A good label, written with use of your detailed field notes, should contain the following information:

- the plant’s Latin name, along with authority, e.g. *Helianthus annuus* L.
- the three-letter abbreviation of the family in which the specimen belongs or the family name spelled out, e.g. AST or *Asteraceae*
- date of collection. This provides important phenologic information about the plant.
- collector (your name) and your serial collection number
- location and elevation where the plant was collected. This detail is important as it informs us about the plant’s distribution, and its location in case we need to return to the population. Collectors today commonly use UTM locations obtained from their GPS units. If you are using a GPS unit, include the datum (e.g., NAD83, NAD27, etc.). Alternatively, you can use latitude and longitude, the Township Range Section, and/or the 7.5 minute quadrangle maps.
• habitat description, e.g. “Upper edge of riparian zone bounded by *Pinus ponderosa-Pseudotsuga menziesii* forest on gentle NE facing slope.” Even the simplest habitat description, e.g. “wet meadow,” can provide information about the plant’s preferences. Additional habitat information that should be included:
  - substrate if known, e.g. “Lava capped mesa in the Denver Formation,” or simply, “granitic substrate”
  - associated plants listed with their latin spelling (common names can lead to confusion and in many cases a common name can be shared by other species. For example, *Leucocrinum montanum* is known by several names including sand lily, starlily or mountain lily.)
  - soil type
  - slope, e.g. steep, flat, etc.
  - aspect, e.g., direction the slope is facing
  - the plant’s habit -- prostrate, tree, shrub, vine, etc., and its size if it is not evident by specimen, e.g. a “20-ft tall tree”
  - any additional information, such as scent, whether the plant has a sap or latex, flower color. Some of these characters may be lost when the plant is pressed and dried. Many flowers do not retain their color, and in many cases the flower color is diagnostic (see Figure 1, below).

**Figure 1**: An easy-to-read label should be written in an 11-point, serif font, such as Times New Roman. Each KHD label will prominently display the state. The herbarium location is in a smaller font at bottom. The sample label to the right is larger than a typical herbarium label; it was enlarged for demonstration. A label should be about 4 x 4.5-5 inches.

**COLORADO, U.S.A.**

**Calamagrostis purpurascens** R. Brown in Richardson

EL PASO COUNTY: Pike-San Isabel National Forest, Pikes Peak, Boemer Creek headwaters below cog railway ca. 1.2 mi. SW of Sachett Mt. 7.5' Pikes Peak Quad, UTM (NAD27) 13S 0497691E 4295417E.

Among boulders on top of minor knob on ridge E. of Boemer Cr. in 50% vegetated tundra, bounded below by *Pinus aristata* forest; associates include *Elymus trachycaulus, Salix glauca var. villosa, Solidago simplex var. simplex, Artemisia scopulorum, Penstemon whippleanus, Erigeron simplex*; caespitose; occasional. Granitic substrate. Elev. 11816 ft.

16 July 2009

Irene Shepard 89, Mike Gellner, Eleanor VonBargen, Janet Wingate

**2009 Floristic Survey of Windy Point & vicinity**

Kathryn Kalmbach Herbarium, Denver Botanic Gardens
PROCESSING HERBARIUM SPECIMENS

Processing refers to the mounting of the pressed and dried plant to 11 x 18-inch sheets of herbarium paper. Herbarium labels (type-written on acid-free paper) and plant specimens are affixed to archival-quality paper. Herbarium sheets include the Kathryn Kalmbach Herbarium name and an accession number on the upper left-hand corner.

For efficiency purposes, pasting labels and gluing specimens should be done be at different times as each activity requires different materials.

Materials needed to PASTE specimen labels to the herbarium sheet:

- paste
- glass sheet or frame
- cup for water
- paint brush
- specimens with labels in newspaper sleeves or between blotters

Once the materials are assembled and the work station is set up for pasting, scoop a small amount - about two teaspoons - of paste from the jar onto the glass frame. Moisten the paint brush with water and then spread the paste onto the glass using painting strokes. Continue spreading the paste until there is a thin, tacky film of paste on the glass. Note: Too much water will cause the labels to bubble and distort (see Photo 4, right).

Place your herbarium sheet and specimen on a flat surface. Using both hands, dab the upper one-quarter of the label back onto the paste-covered glass (see Photo 5, below). Affix the label to the lower, right-hand corner of the herbarium sheet, making sure to place it snugly in the corner so that the underlying herbarium sheet is barely visible (see Photo 6, below). Using both hands, place the herbarium sheet back into its newspaper sleeve and then set the specimen aside. Apply the next label in the same manner and continue the process until the pile of specimens is complete. Replenish paste as needed.
Materials needed to GLUE specimens

- ventilators, i.e., sheets of cardboard, one cardboard per specimen
- small wooden blocks
- small weights, such as washers or bolts
- bottle of archival glue
- archival tape
- paper towel
- probe

Gather and arrange your materials. Place the herbarium sheet with the loose plant specimen on a ventilator. Gently pick up the specimen and hold it in one hand or turn it over and lay it onto a sheet of newspaper. Apply an adequate amount of glue to the “back” of the plant. A KHD staff member will have already positioned the plant in the most appropriate position, so please do not readjust the plant on the herbarium paper prior to gluing. If necessary, apply a generous amount of glue to the plant nodes and root-area, but not so much that it drips and creates a mess (see Photo 7, right). Affix the plant, glue-side down to the herbarium sheet. Note: For scientific purposes, do not apply glue to flowers or fruits.

When necessary, place weights - washers, bolts, small pieces of metal - onto the specimen to keep the plant in place while the glue dries. Do not place the weights over the areas glued as the glue may stick to the weight and could damage the specimen (see Photo 8, right). In many cases, weights are not necessary if the plant was pressed thoroughly.

Place small, wooden blocks at each corner of the ventilator; place another sheet of cardboard on top of these blocks. Place a herbarium sheet, along with the specimen, on top of the cardboard and continue the gluing process. The end result will be a small tower of herbarium specimens (see Photo 9, next page).

Alternatively, you can place one specimen on a sheet of cardboard directly on the table. Glue the plant to the herbarium sheet and carefully set it aside, building your tower to the side rather than in front of you.

Some plants, such as graminoid species, other delicate plants, and species with large inflorescences may require the use of archival tape to affix the plant to the herbarium sheet. Please ask a KHD staff member for a demonstration. If the specimen has loose plant material associated with it, carefully place the material into a fragment envelope. Do not discard the loose
material even if you think you have enough remaining material on the specimen. Glue the fragment envelope to the herbarium sheet, preferably at the bottom edge, but not overhanging the sheet. Do not place the fragment packet directly above the label; this area is reserved for annotation labels.

Photo 9: Processed specimens, on stiff cardboard, are stacked on wooden blocks. The specimens are left in this stack for at least two hours, or until the glue is dry.

ACCESSION BOOK

The accession book is the only paper record of our collections. Prior to entering specimens into the database every specimen is recorded in this book. The information documented is:

- herbarium number (accession number found on upper left corner)
- plant name
- county in which the plant was collected
- collector, and their collection number
- date the specimen was added to the accession book

After the specimens are recorded in the Accession Book, they can be entered into the database and mapped.

A second accession book, called the Reference Accession Book, was created in 2010 to keep track of the specimens being added to the Reference Collection, a collection visitors can quickly refer to determine identification of a plant.

Specimens in the Reference Collection come from a variety of sources. Some are duplicates that were discovered in the Research Collection and were subsequently de-accessioned. Some specimens are from earlier collections that did not have detailed label information necessary to become a research specimen. Some specimens were collected with this purpose in mind.

The information recorded in the Reference Accession Book is similar to the information documented in the Accession Book. However, the information will vary depending on the source.
HANDLING SPECIMENS

Great care and attention to detail are involved in every aspect of collecting and curating an herbarium specimen. To ensure the longevity of these plant specimens, it is important to be mindful when handling any museum object. Always use two clean hands to hold the specimen (see Photo 10, below) and follow the rules of dos and don’ts below.

DO:
- tell a staff person if a specimen is damaged
- let the staff know if plant material came loose from a specimen only if you are certain which specimen the material is from
- notify the herbarium staff if a specimen is misfiled
- tell the staff if a plant is misidentified
- let a staff person know if a specimen lacks an accession number

DO NOT:
- turn the specimen over as you would a page in a book
- turn it sideways or carry it under your arm
- bend the specimen
- pick at the plant material
- remove any pieces of the plant
- attempt to reattach loose plant material
- place anything on top of a specimen or a genus folder
- file specimen folders
- stack several specimen folders on top of each other as they may topple over

Photo 10: Handling specimens with two hands ensures proper support. Mishandled or roughly handled specimens can cause plants to become dislodged or loosened from herbarium sheets.
DATABASE ENTRY
See BG-BASE protocol

FILING
KHD is arranged alphabetically by family and then alphabetically by genus and specific epithet within the families. Colorado, wild-collected specimens are housed in folders that either have blue dots or blue bars across the tops and bottoms of the folders. Cultivated specimens are filed in folders with green dots or green bars. Out-of-state specimens are filed in plain manila folders.

Specimens should have a three-letter family abbreviation on the label, e.g. POA for Poaceae, or the family name spelled out. A list of these abbreviations is available in the herbarium.

It is usually more efficient to arrange the specimens to be filed in groups by family and then in alphabetical order by genus within the family. However, each person may have a way that feels more comfortable. Regardless of the process, find a flat, uncluttered surface and always use both hands when handling a specimen.

Proper handling of the specimen is very important, and equally as important is that the specimen is filed correctly, i.e., in the right folder, and the folder in the right cabinet. A misfiled specimen is as good as lost and serves no value to science.