Making herbarium specimens

Technical Information Sheet 15

Herbarium voucher specimens are a vital part of a seed collection. They are used to verify that seed has been collected from the target species, and are valuable additions to herbarium collections in their own right. This information sheet outlines how to collect, press and dry herbarium specimens.

Before you start, ensure that you adhere to international and local laws concerning biological collections, and have the correct permits and the landowner's permission.

Figure 1: Preparing specimen during field work.

What is a herbarium specimen?

A herbarium specimen (sometimes called a voucher) is a dried, pressed plant (or parts of a plant) which acts as a record of a species at a particular time and place. Specimens are stored in herbaria, and often collectors will send several duplicates (specimens of the same species, made at the same time, from the same place as one another) to different herbaria, for various uses.

What to collect

You need to collect a typical sample of the species you are collecting seeds from (Fig. 1). It needs to be representative of the population, but also of the individual plant you are collecting from. Select a plant which looks like an average of the population, and shows as many features you think may be useful during identification – herbarium specimens must be fertile (have leaves, flowers and fruit – both if possible – and seeds), otherwise they may not be identifiable to species. Where possible, collect underground parts, like rhizomes and bulbs, as these are often crucial for identification.

Recording data and labelling

As part of the collection, you need to record the data for a label which will be mounted with the specimen. This provides useful information about the species which is not visible on the dried specimen, such as:

- Description of location, including provinces and place names, a description of the site, GPS coordinates (latitude and longitude) and altitude.
- Description of habitat, ecology and associated species.
- Plant characteristics, such as habit, height, and any features that won't survive in the dried specimen e.g. flower/fruit colour, smell of flowers or leaves, presence/colour of latex.

Label each duplicate specimen with the same collector name and collection number as your seed collection, so that collections can be cross-referenced.

Herbarium data may be collected in different ways e.g. in a field notebook, or on a field data sheet, if part of a seed collection (see Technical Information Sheet 3).

General principles

Once you have collected your plant specimen, it needs to be pressed and dried. This allows the specimen to be mounted and preserved indefinitely in a herbarium. You should aim to:

- Press the specimens as flat as possible, as this helps prevent them from being damaged and pieces breaking off when they are stored.
- Spread the different parts of the plant with as little overlap as possible, so that they all remain visible when the specimen is mounted.
- Preserve delicate plant parts (like flowers) without crushing them, by folding a piece of light greaseproof paper around them.
- Dry the specimen as quickly as possible to preserve its colour, to prevent disintegration and the growth of mould.

Anatomy of a drying press

Lay the wooden press frames so that the longest slats are on the outside of the press. This helps to distribute pressure more evenly when the press is tightened.

Line the inside of the wooden frame with a sheet of cardboard to prevent the specimens being pressed against the frame and becoming corrugated.

Place layers of blotting paper (blotters) between the layers of newspaper containing your specimens to help draw moisture out of the plants.

Corrugated sheets of aluminium are useful as they heat up and allow air to flow through the press while it is being dried. Cushion them with blotting paper rather than placing them directly next to the specimens in newspaper, otherwise corrugations will be marked on the specimens. Alternatively, use corrugated cardboard with large enough air spaces to allow air flow through the press.

Specimens are usually pressed in sheets of newspaper, because this is absorbant, cheap, easily available almost everywhere and pre-folded. However, some botanists prefer to use 'flimsies' made from thin, strong and slightly absorbant paper (Fig. 2). These may give better results for delicate specimens and in very dry environments.

Straps should be capable of being fully tightened, and withstanding a lot of pressure (for example, a strap of polypropylene webbing with a metal buckle).

When you have finished collecting, tighten the straps around the press so that specimens cannot move around and leaves lie flat. Consider the amount of pressure used: when pressing woody plants, the straps may be firmly tightened. Pressing succulent herbs too firmly may damage the specimen so straps should only be lightly tightened.

Figure 2: The arrangement of layers within a herbarium press, showing aluminium corrugates and blotters between specimens in flimsies.

Figure 3: A fertile specimen arranged on a sheet of newspaper, ready to be pressed.

Arranging specimens in the press

Remove soil and dirt from the specimens and spread the leaves, fruit and flowers out within a folded sheet of newspaper. Turn over one of the leaves to show the underside (Fig. 3), and if there is enough material, try and turn several flowers to show the morphology of the different sides (Fig. 4). Keep the specimen within the sheet of newspaper, as pieces hanging out of the press may be damaged, broken off or not pressed properly. A standard herbarium sheet is about 27 cm × 42 cm, and the specimen should be slightly smaller than this to allow for a border when it is mounted on a herbarium sheet.

Jeweller's tags

As you press each specimen, write the collector's name and number on a jeweller's tag and loop the string loosely around the stem (Fig. 5). Alternatively, loop pieces of paper securely around specimens if jeweller's tags are not available. This ensures that your specimen stays associated with any notes you made about the collection. If the press breaks and the specimens become loose, you will be able to recover some information if the collector's name and number are securely fastened to the plant. Always write in pencil, which doesn't fade. Writing the collector's name and number on the bottom right corner of the newspaper can also be helpful for sorting the collections once they are dried.

Herbarium sheets are a standard size, while living plants are three-dimensional objects of varying sizes, so you will need to fold and cut your specimen accordingly. If the individual plants are small, collect several individuals per duplicate to make a complete collection (Fig. 6). Conversely, if the specimen is too large for the newspaper, leaves and stems can be folded or cut to fit (Fig. 7).

Pressing large leaves

Leaves which are only slightly bigger than the newspaper can be folded with a small amount of overlap, for example with the apex (leaf tip) folded over. Leaves that are much larger than the paper need to be cut into sections, preserving the base, apex and a section of the middle of the lamina (leaf blade). You should record detailed measurements of the original size of the leaf. In some cases a single collection may need multiple sheets, e.g. if the plant has very large leaves and a large inflorescence.

For compound leaves, be careful to take a specimen of the whole leaf, with a section of stem and an axial bud. You may have to fold over the apex of the leaf to make it fit in the newspaper, and also trim some of the leaflets. If you trim the leaflets, leave the petiole and a small piece of the leaf blade on the specimen to show their position.

It is important to show both sides of flowers or floral heads, as one side will be glued down when the specimen is mounted.

Figure 4: Flowers are shown from different sides to show morphological features.

Figure 5: Collector's name and number written on a jeweller's tag and looped around the stem of a plant specimen.

Figure 6: Several small individual plants are needed to form a single duplicate.

It may also be useful to dissect or take cross sections of some plant structures, such as inside flowers, if these features are useful identifiers.

Folding stems

Stems must be folded to fit the size of the paper, and should zig-zag vertically rather than horizontally across the page. This is usually necessary with grasses and sedges, which are often unwieldy. This should be done thoughtfully, as the specimen eventually needs to be mounted and cannot be re-folded once it is dry. Bruising the stems with a fingernail sometimes helps them bend. You can also secure the stems in their folded position using slips of paper with a slit cut in them.

Figure 7: Long grass stems are folded over so that the specimen fits on the sheet.

When you fold a specimen, place the root end in the bottom left hand corner of the newspaper, and fold the stem slightly below the top of the newspaper. If necessary, fold several times.

Bulky plant parts

If there are any parts of the specimen that are significantly more bulky than the rest, pack paper around them in the press so that the pressure remains evenly spread on the stack of specimens. If any part of the specimen is more than 1 cm thick (e.g. taproots, large fruits), you should either slice it into sections and press it as normal, or preserve it by an alternative method, for example by creating a carpological collection (a herbarium collection which is thicker than about 2 cm, stored in a box rather than mounted on a sheet). Large fruits can be dried whole, by placing them directly on a metal corrugate and placing it in the drier. Be careful to label them with the collector's name and number on a jeweller's tag, so that they can be matched up with the leaves and stems that you have pressed separately later.

Duplicates

Duplicates are when several herbarium specimens are made of the same species for a single collection, so different institutions can have the same species record. They should be as similar as possible to one another. You should collect 3 to 6 duplicates of every herbarium specimen, one for the local institution, one for a partner institution, one for any regional or taxonomic experts, and one for another large herbarium. This allows more botanists to see your specimens, and confirm your identifications.

Drying herbarium specimens

Much like drying seeds (see Technical information sheet 08), drying herbarium specimens is dependent on the ambient temperature and humidity, the thickness of the plant material, the air flow through the press, and the papers used. The basic principle is to enable air at 37–60°C to flow through the drying press for 12–24 hours and then check the specimens.

After 24 hours of drying, most specimens should be completely dry. At this point, open the press, check all the specimens and remove any which are dry. Replace wet blotting paper with dry blotters. At this point, if any specimens are still wet, they will be flexible enough

Figure 8: The preferred method of drying herbarium specimens, using an electric fan heater.

that you can rearrange the leaves and fertile parts slightly, if there is too much overlap or they are folded wrongly.

In hot dry climates where the ambient environment provides a constant flow of dry air at above 37°C, you will not need an external heat source, but you will need to change the blotting papers every 24 hours as usual. In colder or more humid environments, you will need to expose your press to an external heat source, such as a drying room or oven. In the field, this may not be available, so you may need to improvise heat sources such as those suggested below.

Once dry, seal specimens in plastic so that they do not reabsorb moisture from the atmosphere and your drying efforts are not wasted.

Box 1: Plants requiring special treatment (seek specialist advice)

- Aquatic plants: use perforated waxed paper, or thin nylon or muslin fabric to press (they will stick to newspaper and flimsies). Use additional sheets of drying paper and change frequently. For fully submerged plants collect into a plastic bag, keep in a fridge and take to a specialist within a few days. Aquatic plants can also be collected into alcohol.
- Succulents: slice longitudinally and/or transversely, scoop out inner tissue. Dry quickly, or alternatively preserve in alcohol.
- Very large-leaved plants, for example palms and Musaceae: take measurements, photographs and make notes, then collect sections of leaves (base, middle and apex) and inflorescence (all orders of branching). Fold sections to fit the press and label parts sequentially.
- Plants with fleshy underground parts: slice lengthwise, press sections and ensure the fleshy parts dry completely.
- Plants with complex 3D structures e.g. orchids: preserve an example in alcohol (see page 4).

Drying with an electric fan heater

This is the best method for drying herbarium specimens, but it requires a reliable electricity supply and good quality equipment. During the first hour of use, regularly check that plugs and cables are not overheating. Drying herbarium specimens with an electric fan heater carries a much smaller risk of fire compared to using the gas method explained below, but electric fan heaters but must be constantly monitored and a smoke detector should be suspended above.

Use an electric fan heater of around 1,000 kW, or a 2,000 kW heater on a low heat setting. Secure a tarpaulin around the fan heater and press, so that the tarpaulin inflates and the hot air passes through the drying press (Fig. 8). Use foldback clamps or staples to close any gaps. The drying press must be at least 20 cm thick; if drying just a few specimens, add empty corrugated sheets until minimum thickness is reached. Carpological collections, e.g. large fruits, can be dried inside the tarpaulin.

Drying over a portable gas burner

If there is no reliable electricity supply, portable gas burners can be used.

Figure 9: Drying specimens over a gas fire. A metal cage prevents the tarpaulin getting too close to the heat source.

Suspend the drying press 0.5–1 m above the heat source by elevating on wooden boxes or hanging from a ceiling beam or tree. Direct the heat (and protect the press from rain) by wrapping a tarpaulin around the press and stove, ensuring that air can exit from the top of the press. Use a fine metal wire mesh to prevent plant material falling onto the burners (Fig. 9). Make sure the flames cannot reach the tarpaulin or press; specimens are very flammable, and overheating will cause them to become brittle and lose colour.

Use several small gas burners (between 1 and 4, depending on the size of the press to be dried) on their lowest heat setting and adjust the temperature by adding or removing a burner. Change gas cartridges as necessary. Ensure adequate ventilation when drying with external heat sources like gas burners to avoid fire and carbon monoxide hazards.

Drying over a charcoal fire

The drying press can be suspended over a charcoal fire, but care must be taken that smoke does not pass through the press. If the fire produces too much smoke, suspend the press inside an oil drum cut into two halves.

Short term preservation in alcohol

Specimens left in a press for days will start to disintegrate and make very poor specimens. If you are away from drying facilities for several days and cannot use a field method of drying, the Schweinfurth alcohol method might be necessary. The specimens (still in the press) are placed in a strong plastic bag, 0.5 litres of 60%–80% alcohol is added, and the bag is tightly sealed until the specimens can be dried by the usual method.

The alcohol method should only be used as a last resort as it makes inferior specimens. Specimens preserved in this way will be discoloured, the plant chemistry will be changed (for example oils and waxes may be dissolved) and their DNA may be adversely affected.

Preserving 3D structures

If your specimen has fruit or flowers where retaining their three-dimensional structure is important for identification (e.g. orchids), you can preserve them in 70% alcohol. Place the specimen inside a leak-proof bottle or plastic bag, cover with alcohol and seal tightly. Specimens preserved in spirit will lose their colour, so take notes and photographs to record this. Specimens preserved in alcohol may not be permitted on airlines.

Sending herbarium specimens

It is important that specimens are sent to herbaria unmounted. This is because most herbaria will have their own ways of mounting and specifications around what size and type of paper specimens are to be mounted on. Specimens do not need to be secured to the paper in order to be transported, and sellotape should never be used on any part of a herbarium specimen as its removal will damage the specimens.

Specimens should be fully dried before sending to make them more able to withstand the journey. Send each specimen in its own piece of dry newspaper, ensuring collection numbers are still attached. Put stiff cardboard at the top and bottom of the stack of specimens, and tie securely with string (Fig. 10).

Pack specimens flat and horizontally, and take care to ensure that the parcel remains that way up during transit.

Fill any spaces in the box with packing material to reduce the amount the specimens will move. You should always send the relevant data with specimens.

If your specimen is crossing country borders, you must check import/export legislation. Some families (such as Orchidaceae) are also subject to regulation under the Convention on International Trade in Endangered Species (CITES).

Figure 10: A stack of unmounted dried specimens ready for shipping.

Box 2: Equipment

Equipment for the field

- Tools for cutting: secateurs, pole pruners, pruning saw
- Gloves to protect against thorns, irritant hairs or latex
- Field press in a bag: cardboard, newspaper, straps
- Jeweller's tags
- GPS, manual and spare batteries
- Field notebook, pencil
- Camera
- Dissection kit with scalpel, forceps
- Hand lens

Equipment kept at base

- Full drying press with wooden frames, blotting paper, metal corrugates and straps
- 1000kW electric fan heater, gas stove, or other device to expose press to a steady flow of air at 37–60°C

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Further reading

Davies, N., Drinkell, C., Utteridge, T. (2023) The Herbarium Handbook. Royal Botanic Gardens, Kew.

Victor, J.E., Koekemoer, M., Fish, L., Smithies, S. J., & Mössmer, M. (2004) Herbarium essentials: the southern African herbarium user manual. Southern African Botanical Diversity Network Report No. 25. SABONET, Pretoria. Available from: https://www.sanbi.org/wp-content/uploads/2018/04/sabonet-report-no-25-herbarium-essentials-southern-african-herbarium-user-manual.pdf (26/07/18)

Queensland Herbarium. (2016). Collection and preserving plant specimens, a manual. 2nd edition. Department of Science, Information Technology and Innovation, Brisbane. Available from: https://www.qld.gov.au/environment/assets/documents/plants-animals/herbarium/collecting-manual.pdf (26/07/2018)

Equipment specifications*

Description	Model and supplier
Global positioning system unit (GPS) and maps	GARMIN GPSMAP 64 www.garmin.com
Herbarium drying press (herbarium plant press and nylon webbing straps), corrugated aluminium or cardboard ventilators & field press	www.herbariumsupply.com
Blotting papers, electric fan heater (1000kW or 2000kW with adjustable heat setting), jeweller's tags, portable gas burner, leather gloves, heavy gauge plastic bags & tarpaulin	Locally available
Hand lens	https://www.nhbs.com
Secateurs	www.worldoffelco.co.uk
Dissection kit	Scalpel, forceps of different sizes/types www.fisher.co.uk

*Please note that the above equipment is used by the Millennium Seed Bank and has been chosen carefully using our many years' experience. The list of suppliers is for guidance only and does not represent an endorsement by the Royal Botanic Gardens, Kew. The manufacturer's instructions must be followed when using any of the equipment referred to in this Information Sheet.