



# introduction

*...from Africa—for Africa*

*Frithia pulchra* (Mesembryanthemaceae).

Many plant species are threatened with extinction through human activity. Southern Africa has over 30,000 species of flowering plants and ferns, but is poorly equipped to monitor and evaluate this heritage. We believe that establishing, expanding, and improving herbaria is the first and most important step towards achieving this objective.

*Herbarium Essentials* is an illustrated, Afrocentric manual for herbarium workers, supplying the basic information about a functional herbarium. It provides a theoretical background, as well as comprehensive methods for running a herbarium, taking its different aspects into account. These aspects include plant collecting, mounting, scientific and physical curation, as well as computerisation. The combination of theory and practical expertise will equip you with the essential knowledge required to work in and run a herbarium.

We hope that this book will serve as a valuable resource and guide for all herbarium professionals in southern Africa and further afield.

Tournefort first used the term “herbarium” to describe a collection of dried plants in 1700. Later, Linnaeus took up the term and it has been used in this context ever since. A herbarium is a collection of dried plant specimens arranged in an accessible system. It is an important source of data used by researchers in many plant-related sciences and is most often used for

taxonomic research. Herbaria are centres where plant taxa are studied. This includes identification (how they are recognised), nomenclature (the naming of specimens to avoid the problem of ambiguity), classification (grouping of plants with similar properties), distribution (where it grows), ecology (the kind of habitat), and use (useful properties). They are funded by national or local governments, universities, private institutions, research organisations, scientific societies, or individuals, and differ vastly in size and main function.

## Herbaria of the world

The largest herbaria in the world are all in the northern hemisphere. These herbaria are all far larger than any of the herbaria in the southern hemisphere. In Africa, only one herbarium (PRE) houses over a million specimens.

Smith, Willis & Mössmer (1999) have compiled the most comprehensive survey of southern African herbaria. The survey shows that most of the larger herbaria in the subcontinent are in South Africa.

## Functions of herbaria

Herbaria have one or more of the following functions or roles:

- Conservatory of dried plant material
- Archival record of a region’s flora
- Source of botanical information and diversity



Staff working in a herbarium.

Largest herbaria in the world		
Herbarium (ACRONYM)	Country	Number of specimens
Paris (P, PC)	France	8,877,300
Kew (K)	United Kingdom	6,000,000
Leningrad (LE)	USSR	5,770,000
Stockholm (S)	Sweden	5,600,000
New York (NY)	U.S.A.	5,300,000
British Museum (BM)	U.K.	5,200,000
Genève (G)	Switzerland	5,000,000
Harvard University (A, AMES, ECON, FH, GH, NEBC)	U.S.A.	4,858,000
Smithsonian (US, USNC)	U.S.A.	4,368,000
Montpellier (MPU)	France	4,000,000

Source: Holmgren et al. 1990

Largest herbaria in the southern hemisphere		
Herbarium (ACRONYM)	Country	Number of specimens
Bogor (BO)	Java	1,600,000
Pretoria (PRE)	South Africa	1,200,000
Sydney (NSW)	Australia	1,000,000
Melbourne (MEL)	Australia	1,000,000
Adelaide (AD)	Australia	700,000
Wellington (CHR)	New Zealand	600,000
Indooroopilly (BRI)	Australia	523,500
Canberra (CANB)	Australia	500,000
Nairobi (EA)	Kenya	500,000
Rio de Janeiro (R)	Brazil	500,000

Source: Holmgren et al. 1990

Largest herbaria in southern Africa		
Herbarium (ACRONYM)	Country	Number of specimens
Pretoria (PRE)	South Africa	1,200,000
Harare (SRGH)	Zimbabwe	513,700
Compton (NBG & SAM)	South Africa	507,000
Bolus (BOL)	South Africa	335,500
Grahamstown (GRA)	South Africa	200,800
Natal University (NU)	South Africa	120,000
Wits University (J)	South Africa	100,000
Natal (NH)	South Africa	100,000
Schweickerdt (PRU)	South Africa	100,000
Malawi (MAL)	Malawi	84,000

Based on Smith, Willis & Mössmer 1999

- Recorder of plant names
- Supplier of a support service to the community: plant identification, information, education, collecting services for bio-prospecting or other specialised projects
- Training for botanists
- Research

## Different types of herbaria

We can identify many different types of herbaria, based on the kinds of specimens they house.

- **International** herbaria keep specimens from all over the world.
- **National** herbaria keep specimens from all regions within a specific country.
- **Regional** herbaria keep specimens from a specified region or province within a country.
- **Local** herbaria keep specimens from a small area within a region or province.
- **Teaching or academic** herbaria are attached to a training institute and are generally a place where students deposit their collections.
- **Private** herbaria are kept by individuals, or are attached to private land, such as farms or private nature reserves.
- **Research** herbaria usually house voucher specimens representing one of the following:
  - A specific research field, for example, medicinal plants, weeds, or useful plants
  - A distinct family, for example, Fabaceae or Asteraceae
  - A specialised plant group, for example, water plants or bryophytes

## Specialised collections within herbaria

There can also be special collections within a single herbarium.

- **Historic:** Very old collections that are kept separate and in their original state, for example, the South African Museum (SAM) collection in Compton Herbarium, (NBG), Cape Town. Cupboards and covers are unchanged and often not curated; for example, name changes are not incorporated.
- **Vouchers:** Voucher specimens for ecological, anatomical, cytological, chemical, or molecular studies.
- **Special Interest:** Groups of plants with a linking quality, for example, medicinal plants. ▲



## How this book is arranged

**CHAPTER 1** discusses the different **types of collections** a herbarium contains and also briefly describe the different ways in which collections are expanded.

**CHAPTER 2** gives a detailed account of **plant collecting**; including the equipment you need for collecting, what to collect, how to collect, and how to record information in the field.

**CHAPTER 3** illustrates how to go about **pressing and drying** your specimens. We describe, in detail, standard as well as special pressing methods.

**CHAPTER 4** explains why specimens are mounted, describe the materials and equipment you need, and illustrate various **mounting** procedures.

**CHAPTER 5** discusses the different aspects of **physical curation**—storing, labelling, filing, and repairing specimens; making indexes, cupboard lists, and quick guides; handling loans and duplicates; and computerising the collections.

**CHAPTER 6** evaluates methods for the prevention and treatment of **herbarium pests**.

**CHAPTER 7** describes **scientific curation** of the herbarium collections, with emphasis on taxonomy and nomenclature, identifying specimens, and incorporating new research.

**CHAPTER 8** summarises the essential procedures for setting up a **new herbarium**, from determining the basic needs of your herbarium, to herbarium management.

**APPENDIX 1** lists local and international suppliers of herbarium materials.

**APPENDIX 2** shows a typical field label.

The comprehensive **INDEX** will help you find the information you need.

A photograph of two vibrant red flowers with multiple petals, laid out on a white rectangular herbarium sheet. The sheet is placed on a dark, textured ground surface, possibly soil or mulch, with some dried plant matter and twigs scattered around. The flowers are positioned symmetrically on either side of the center of the sheet. The background of the entire slide is a solid reddish-brown color.

CHAPTER I

# herbarium collections

*Creating a balance between the use,  
management, and conservation of  
collections is a significant challenge.*

*—Williams & Cato, 1995*

To a large extent, a herbarium consists of its collections of preserved plant specimens. This chapter discusses the different types of collections and how they are established and maintained, as well as ways in which a herbarium increases its collections.

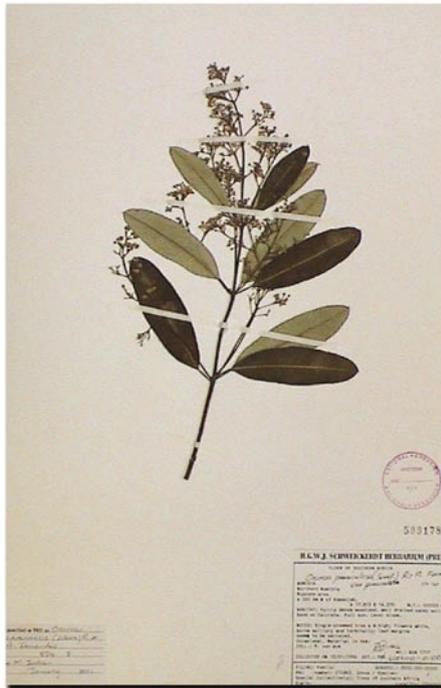
In addition to the main collection of pressed, mounted specimens, a herbarium can contain collections of fruits and seeds, bulky specimens, wood samples, bryophytes, fungi, fossils, and plant material stored in preservatives. Illustrations, photographs, and copies of specimens, as well as microscope slides, also form part of the herbarium's collections.

## Types of collections

Angiosperms are usually pressed and then stored dried and mounted on sheets of card. These specimens are stacked on top of each other and stored on shelves in cupboards. Some plants or organisms, however, cannot be mounted and stored in this way. Apart from the main collection, there are therefore a number of ancillary collections containing fossils, fungi, lichens, and bryophytes. Seeds, fruits, and wood are also stored for taxonomic purposes. Sometimes specimens are stored in liquid chemicals in glass bottles. These ancillary collections are usually housed separately, requiring the herbarium collections to be divided spatially.

## Main collection

The main collection, consisting of angiosperms and pteridophytes, may or may not include cultivated plants and gymnosperms; in some herbaria either or both are housed separately. Herbarium staff, staff from other local institutes, and individuals collect most of the specimens incorporated into the main herbarium collection. Some specimens are gifts, or are gained from an exchange system with other herbaria. Specimens that have been used for research purposes (for example, anatomical or ecological studies) are deposited in herbaria by the researchers for future reference. They are termed voucher specimens.



A plant specimen, pressed, dried, and mounted for storage in a herbarium.

## Carpological collection

A carpological collection consists of cones, fruits, or seeds and is housed separately. Each is cross-referenced with the corresponding herbarium sheet.

Exceptionally large specimens, for example, cycad cones, are best kept in boxes. The best boxes are made from cloth-covered hardboard. Their design should have a drop-flap front as well as a lid-top. The collector's label should be glued to the outside of the box, or the box can have a label-holding slot. In tropical herbaria it may be better to house specimens in metal boxes, as these are more insect-proof.

Seeds and fruit, stored in the herbarium for taxonomic purposes, are kept in boxes or bottles in metal filing cupboards with shallow drawers. It is vital that seed is kept dry to prevent germination. Fleshy fruit can also be kept as spirit material. (See "Spirit collection".)

All seeds must have a voucher specimen in the main collection; otherwise, they are worthless for scientific research.

Seeds may be stored for future cultivation or re-introduction for conservation purposes, in which case, special conditions are needed to maintain their viability. For short-term storage (days, weeks, or months), seeds may be kept at 5°C (in a normal refrigerator) in an airtight container with silica crystals to absorb moisture. Long-term storage (longer than one year) requires seeds to be stored at -20°C to -5°C. Stored seeds should not be exposed to warmth or moisture, or they will germinate or become non-viable.

## Bulky specimens

Bulky plant parts, such as palm fronds, can be stored in archival folders or drop front boxes with a label glued to the outside.

## Xylarium

A collection comprising only wood specimens is known as a xylarium. Wood can be stored for two main purposes: one is to provide samples from which sections may be taken for anatomical studies; another is to provide information about the trees for purposes of identification or description. Blocks of wood can

**TIP** A more detailed discussion on how to collect, press, mount, and archive plant species follows in Chapters 2, 3, and 4



**Wood specimens.**

have one side polished and the other side unpolished, and it is useful to have a bit of bark attached. The blocks can be stored in cupboards or drawers. The easiest way to store wood is to catalogue the blocks and file them in numerical sequence.

For every wood specimen, there must be a corresponding voucher specimen in the main collection. Each block should have a catalogue number written on it and this number must be written on the herbarium sheet on which the voucher specimen is mounted. Without this cross-reference, the wood collection is of no value.

If no separate wood collection is available, small pieces of wood can be mounted on herbarium sheets.

### Bryophytes and lichens

Bryophytes and lichens are not mounted on cardboard sheets like other plants—they are kept in folded envelopes. (For more information on collecting and drying bryophyte specimens, see “Bryophytes”, and “Drying specimens”. For more information on storing bryophytes and making envelopes, see “Storing bryophytes and lichens”).

### Macrofungi

Macrofungi should be stored whole or sliced lengthwise. Spore prints and drawings of microstructures should be stored with the specimens. Fungi are particularly susceptible to insect attack and should be disinfected thoroughly before storage.

Store fungi in one of the following ways:

- In sealed polythene bags, with a few crystals of silica gel to keep the specimen dry.
- In a desiccator over calcium chloride.
- In small cardboard boxes containing silica gel if the specimen is particularly fragile.

### Fossils

Fossils are usually large and bulky and are best kept in metal

filing cupboards; specially designed cupboards with shallow drawers with adjustable spacing are ideal. The drawers should be lined with a thin layer of foam rubber. Each fossil should have a small label with a catalogue number attached to it. The collection information can now be recorded in a book, or on the computer. If the fossil is very small, it can be mounted either on card, or on a larger piece of rock from the same locality. The rocks can be kept in stratigraphic order and within that, locality order. Within each locality, the specimens can be ordered taxonomically. Alternatively, the fossils can be ordered by organ type.

### Spirit collection

Very fleshy or delicate structures or complex flowers, such as those of the Asclepiadoideae, are stored in liquid chemicals or “spirits”. The advantage of this method of storage is that the three-dimensional shape of the specimen is maintained. Plant material preserved in this way can be used for anatomical research and for taking measurements of features that shrink when the plant material is dried. Specimens are usually fixed to prevent their anatomical distortion, and then stored in jars with preserving liquid, for example, alcohol or Industrial Methylated Spirits (IMS). For more information, see “Fixatives”.

### Illustrations, photographs, and copies of specimens

Illustrations or photographs are useful in providing a permanent record of the habit, habitat, and colours of the plant. Prints or slides can be used in publications and lectures. They may prove to be of great value if they depict habitats as they were before being destroyed, or species as they were before becoming extinct.

Photographs, photocopies, or scanned images may also record specimens from other herbaria, such as types, historical specimens, new taxa, or taxa not represented in the collections.

Illustrations and photographs should be mounted on standard herbarium sheets. Each print or slide should be labelled with the collection information: name, locality, collector’s name and number, date, and so on.

Photographic work emanating from research, such as anatomical, cytological, or SEM (scanning electron microscope) studies, may be kept with the voucher specimens. They can be kept together in a zip-closure plastic bag. Negatives should be kept separately and cross-referenced.

Photographs can be filed in the main collection; if corrosive sublimate is used for fumigation however, photographs should be kept elsewhere.

Slides and negatives can be kept in special holders and filed in a filing cupboard with cross-references to herbarium specimens where relevant.

### Microscope slides

Slides with sections, such as anatomy, pollen, or other preparations for microscopic examination, are kept in a special cupboard with drawers made to hold them. They may be numbered serially and the serial number placed on the corresponding herbarium sheet. Alternatively, collectors' numbers may be used.

### Expanding the collections

Specimens covering a wide range of habitats of the taxon's distribution range and variability will provide more information on the relationships of taxa. Collections are expanded in several ways.

### Plant collecting

Collecting is the most obvious way of expanding a herbarium collection. Anyone with the necessary permit may collect plants and donate them to a herbarium. Keep in mind that there are specific guidelines on how plants should be collected, pressed, and dried to be of high enough quality to be stored as an archival record. For more information, see "Collecting Plants" and "Pressing and Drying".

When staff members spend a lot of time in the field making collections, these usually form the main body of research material. Field trips, however, are costly and time-consuming and herbaria often have to rely on other methods for obtaining specimens. Collectors should be encouraged to collect duplicate specimens. In this way, the extra sets may be used for exchange, which is another way of expanding the collection.

### Gifts

Herbaria may donate duplicate specimens to other herbaria. Gifts of herbarium specimens may either be given freely, or donated in exchange for identifications. This makes the information on the plants generally available and the results of study and identification are disseminated in a permanently available form. Individuals may also donate unidentified specimens to herbaria and, in return, the herbarium will provide them with names. Gifts are incorporated into the herbarium, provided the specimens and labels are of a high enough quality.

Should an employee of one herbarium go on a collecting trip to a region covered by another herbarium, it is good etiquette to collect and donate duplicate specimens to the herbarium in the region. Sometimes one of the conditions attached to the issuing

of a collecting permit, is that the herbarium of the region receives duplicate copies of all specimens collected in that region. Gifts of sets of specimens from investigations or explorations by botanists with no herbarium affiliations are frequent. Botanists will be encouraged to give sets of specimens to herbaria that have a reputation for active research and an interest in increasing the collections, particularly if a policy is in place that ensures that material will be kept, cared for, and accessible.

### Deposits

The difference between a gift and a deposit of material is that, in accepting material on deposit, the herbarium is obliged to keep the specimens in the collection. The herbarium cannot discard them or send them out on exchange. Valuable specimens that serve as vouchers for published records, for example, drug plant investigations, ecological work, or legal evidence, are often received under such conditions. Voucher specimens are frequently very carefully made and often carry valuable information that is not ordinarily available. Every effort should be made to encourage such deposits, especially as they are likely to stimulate the interest of non-taxonomic botanists and other scientists in the herbarium.

### Exchanges

Herbaria may have exchange systems with one another—for every specimen donated by one, the other donates a specimen in return. The material sent for exchange should be of such quality that the receiving herbarium is happy to incorporate it into its collection. Herbaria involved in exchange systems may put in requests for certain taxa or regions. If this is the case, consider these requests when sorting duplicates.

Exchange policies should retain sufficient flexibility to ensure that material is sent where it would be of most value, regardless of that institution's exchange "credit". Herbaria with a policy for saving space may encourage duplicate specimens to go elsewhere. ▲



Fossils can be stored in metal cupboards with shallow drawers.