

# HOW TO COLLECT PLANTS

This section incorporates material that is available in a booklet published by the National Herbarium of New South Wales (Bedford & James, 1992) and in similar documents published by other herbaria (e.g. Albrecht, 1993; Harden & Williams, 1979). The purpose of these publications is to provide information for people collecting and preserving specimens for their own identification, or identification by the relevant herbarium. However, much of the information will assist students and others involved in collecting, preserving and identifying specimens. More detailed information on mounting, labelling and storing specimens is also included to assist those who wish to maintain their own permanent collection.

To conserve the biodiversity of species, collection of all plants should be undertaken with care. Picking of plants within national parks, nature reserves, and state forests, or species listed on schedules on relevant acts of parliament, is prohibited unless a permit has been obtained from the relevant authority. Permits are generally only given for scientific studies. However, any species listed in the schedules in the *National Parks and Wildlife Act 1974* and *The Threatened Species Conservation Act 1995* should not be collected without a licence from the National Parks and Wildlife Service. See Chapter 4 on Conservation of Plants for more details.

## 1 Why collect specimens?

To identify a plant it is necessary either to take the relevant identification books into the field to the plant, or bring the plant (or part of the plant) back to the identification guides. It is not sufficient to 'remember' what the plant looks like, or to take a photograph, as in most instances it is necessary to examine the parts of the flower, fruit and leaves in detail. In many cases it is not possible to examine the plant specimen immediately so it is best to preserve it so that it can be examined at a later time at one's convenience.

Specimens of most plants can be preserved indefinitely by careful drying, followed by storage in dry, insect-free conditions. Although lacking the freshness and colour of live material, dried specimens, with notes taken in the field, usually provide most of the features required for identification and for botanical study.

Specimens accompanied by notes taken in the field at the time of collection provide a voucher of the occurrence of that species at that time at the given locality. Specimens can be re-examined at a later date where there is doubt over the identity of the record. If a record of a species is new for an area (e.g. extension of the known distribution of a native species, or a record of a recently naturalized species for the area), it is important to send a specimen to the relevant state herbarium for confirmation. The lodgement of annotated specimens at a state herbarium builds up the known distribution of species within the state and is a basis for future botanical and ecological research work.

A herbarium is a collection of dried plants; it may be a small private collection or a large collection such as that housed at the National Herbarium of New South Wales at the Royal Botanic Gardens Sydney. This collection contains almost a million specimens and is the largest collection of plants of N.S.W. and one of the most comprehensive collections of Australian plants in the world. These specimens provide a record of past and present distribution of plant species and are used as a basis for correct identification of species, and for botanical and ecological research on the Australian flora.

## 2 Equipment for collecting plant specimens

Basic equipment that is readily available (or can be purchased easily) will enable the collection of plant specimens to be much more effective and less wasteful of the specimens obtained. Such equipment would include:

- *notebook* - to record information in the field
  - *secateurs* - for cutting specimens
  - *tags* - for numbering specimens
  - *plastic bags* - large (for plant specimens) and small (seeds etc.)
  - *water* - to moisten specimens once placed in bags;
  - *rubber bands* - to seal plastic bags
  - *hand lens* - to examine specimens in the field
  - *pen/pencil* - for recording information on tags and in notebook
  - *ruler* - for measuring variation of leaves etc.
  - *plant press and newspaper* - for pressing plants.
- Jeweller's tags are readily available in bundles at stationery shops.



Equipment for collecting and pressing plants.

### 2.1 Use of a hand lens

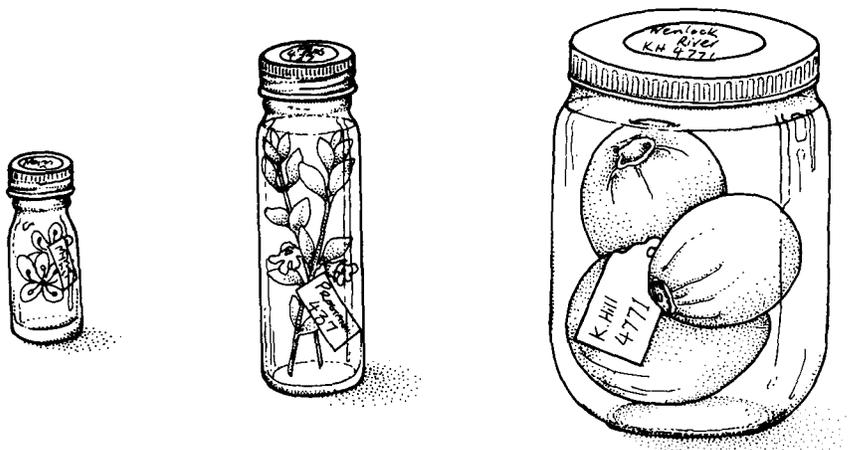
A 10 x hand lens is adequate for most field work as well as in the laboratory, if a microscope is not available. These can be purchased from most optical or surgical suppliers. Learn to use the hand lens properly - it is important to use it when looking at details of hairs, glands, oil dots, leaf buds, fine veins, etc. The essential point is to hold the lens close to the eye and to bring the specimen up with the other hand until the lens is focused on it. Thus the specimen is moved back and forth to get it in sharp focus, rather than moving the lens. There are two advantages: first you get a wide field of view and the greatest useful magnification that the lens can provide, and secondly, it is much easier to get good light on the specimen without shadows being cast on it by the lens.

### 3 How to collect specimens

Before starting to collect specimens it is a good idea to examine the size of the population and the degree of variation of the species within the population. If it is considered necessary to collect a specimen, care should be taken that the population is sufficiently large to cope with the removal of one or more plants (if it is a herb) or part of a plant, if it is a shrub or tree.

#### 3.1 *Wet or spirit collections*

Very fleshy or delicate structures (including fragile or structurally complex flowers and fruit, small annuals, some aquatic species, or small algae) may be preserved in a liquid preservative rather than by drying, in order to maintain the original shape and 3-dimensional structure of the material. Specimens preserved in solution in airtight glass or plastic jars are often referred to as 'spirit collections' or 'wet collections'. In most instances glass jars are preferable to plastic as they seal more tightly, and as they are clear it is easier to see contents. Small glass bottles used for scientific specimens are called Macartney bottles. Most material can be satisfactorily preserved in 7 parts of ethanol (ethyl alcohol) with 3 parts of water to give a 70% solution, usually referred to as 70% alcohol. However, if you cannot obtain the ethanol easily, methylated spirits may be substituted and made to a 70% solution.



Macartney bottles and glass jar with preserved specimens.

The type of preservative used should be shown clearly on the label. This information, together with the collection number for the material, should be written in pencil on a small piece of paper (since many inks are alcohol-soluble) and placed in the container; an additional label should be put on the lid of the container, and this should be written with archival ink.

Colours fade quickly in these solutions so it is a good idea to keep comprehensive notes and photographs of the colours of flowers and fruit. The specimens tend to become flaccid so it is usually advantageous to have these collections to complement pressed and dried specimens, rather than relying on them as the only material.

#### 3.2 *Pressed and dried collections*

Most collections held in herbaria are preserved as pressed and dried specimens, as this is the easiest method of handling and storing plant collections. The following sections in this book apply to pressed specimens unless indicated otherwise. Occasionally specimens are allowed to dry without pressing, so as to retain the natural orientation of the organs (such as leaves or flowers on the stem) or because the specimens are too bulky to press satisfactorily.

In most instances specimens should be as complete as possible, to facilitate identification and to be useful as a plant collection. A typical branch or portion of the stem about 20 - 30 cm long, showing the leaves in position and with flowers, is required. In the absence of open flowers, buds should be included as they can be dissected to give the number and arrangement of the flower parts, as well as the type of inflorescence. Developing fruits can be dissected to show the number of loculi in the ovary and the arrangement of the ovules. If variation in leaf form is apparent, specimens should include different parts of the same plant to represent this variation. Fruit and/or seeds can be useful in the identification of plants and should be included with the specimen if available; these can be collected and stored in plastic or paper bags.

The size of a specimen is usually governed by the size of the sheet on which it is to be stored. Samples about 30 cm long make suitable specimens of most species, as herbarium sheets are usually about 43 cm long x 28 cm wide. Smaller sheets (e.g. foolscap size, about 32 cm x 23 cm) may be used if necessary, but smaller sheets are not recommended since they encourage the collection of inadequate specimens. However, cards (20 cm x 13 cm) may be used for ready-reference collections as they can be conveniently taken into the field, or stored in a card cabinet. Such small samples are useful for localized field reference collections but are not recommended for specimens that are to be used for a long term collection for the systematic study of specimens.

For plants with large leaves or massive fruits, do not limit the size of the specimen for convenience. It is more important to have a complete and, therefore, useful specimen than to conform to arbitrary rules on the accepted size of the collection (see below about storage of large specimens).

The features most important for identification vary between different plant groups. The major plant groups and some specific requirements are listed below.

**Bryophytes** - Mosses, liverworts and hornworts are small non-vascular plants that are slow growing and usually form mat-like or cushion-like colonies that cover the substrate. Many of these species grow on the bark of trees, on rocks, or on the soil surface. The plant (or small part of the colony) is placed in a paper bag or an envelope made from folded newspaper, and allowed to dry, without pressing. These plants are easy to collect and store but are quite difficult to identify as there is no flora of bryophytes for N.S.W. However, many plants can be identified at least to genera from *The mosses of southern Australia* (Scott & Stone, 1976) or *Southern Australian liverworts* (Scott, 1985).

**Lichens** - Lichens, like bryophytes, are usually small, slow-growing plants that are sensitive to disturbance. These organisms are treated in the same manner as bryophytes if they are to be collected and preserved. There are three types of lichens, classified on the form of the plant body or thallus: **crustose lichens** that are pressed tightly against the substrate; **foliose lichens** that have spreading leaf-like lobes and **fruticose lichens** with a branched cylindrical or flattened body that is not leaf-like. In most instances part of the substrate should be carefully removed with the lichen, and fruiting bodies should be included as part of the collection.

**Ferns** - Specimens should include fertile (spore-bearing) fronds and sterile fronds, as well as part of the rhizome (if present) or stalk of the frond (stipe). For tree-ferns, a portion of a fertile frond and the base of the frond stalk bearing scales or hairs should be collected.

**Herbs** - In the case of small herbs the whole plant should be collected by digging up the entire plant. By collecting the whole plant it is possible to see the arrangement of the aerial parts of the plant in relation to each other, as well as the details of the roots and/or any underground storage organs. However, if the plant is uncommon, a note on the characteristics of these parts should be

made, leaving the basal parts to shoot again in the following year. This is especially important in the case of orchids and rare species.

**Grasses** - Grasses and other plants of grass-like habit should be collected whole so as to show the rootstock. Grass clumps may be broken up into small tufts of leaves and flowering stalks, and two or three of these tufts should make a satisfactory specimen. All dirt adhering to the roots should be carefully knocked off or washed away. Grasses are best collected after the flowers have opened, but before fruits are ready to drop. If the grass specimen is longer than the herbarium sheet, it should be bent once, twice or more, so as to form a V, N or M (according to its length) and pressed in this position. Attempts to bend it after it is dry will probably cause it to break. In the case of exceptionally tall grasses the flowering parts and a piece of the basal parts should be collected, and a note made of the height and habit.

**Trees** - For most species it is necessary to collect flowers, fruit and leaves; however, in large trees, it is often difficult to collect flowers and/or fruit. In some instances vegetative material of species that grow in rainforest is adequate for identification and as a specimen to record its distribution; however, if at all possible it is preferable to collect flowers and fruit. Notes should be made on the form of the tree, and on any other distinguishing features, such as coloured sap or type and colour of the bark.

Eucalypt specimens should include flower buds, as well as fruits, adult and juvenile leaves (the latter often from epicormic shoots or suckers near the base of the trunk). Notes should describe the type of bark (rough, smooth, stringy or fibrous) and if rough, how far it extends (e.g. over the base of the trunk only, on the main branches, and/or on fine twigs); sometimes it may be appropriate to collect a wood and bark sample as an ancillary collection.

**Plants with large inflorescences or other large parts** - When collecting plants such as agaves, palms or grass trees (*Xanthorrhoea* species), the lengths of the flowering and non-flowering parts of the inflorescences and trunk heights should be noted. For plants such as large-laved palms and aroids, the smallest complete leaf is many times larger than the standard sheet. There are two collection and storage methods for such plants. One is to cut the leaf into a number of segments (carefully numbered) to mount onto separate sheets. This has the advantage of not requiring alternative storage areas. Disadvantages include the need for additional documentation, preferably including photographs, and the difficulty of relating the specimen to the living plant. The alternative technique is to collect the leaf whole and to provide special separate storage for such material. The main disadvantages of this technique are that the material is difficult to handle (press and dry) and greater storage space is required.

**Small algae** - Small algae are often collected by scooping the water containing the algae into a jar. If the algae are to be stored for more than several days, a preservative needs to be used. This traditionally has been formalin added to the water to make a 5% solution. However, formalin is extremely toxic and care should be taken not to breathe its vapour. Such a solution should not be sent through the post or by courier. A safer option is to add sufficient concentrated alcohol or methylated spirits to the water containing the algae to make a final solution of 70% alcohol. It is preferable to concentrate the algae first (e.g. by filtering) so that the amount of liquid stored is much less and it is easier to find the organisms. Another option is to fix the algae in formalin (or something similar) and then mount the concentrate on a glass microscope slide with a permanent water-soluble medium. The jar or slide should be clearly labelled with the preservative used.

**Macro-algae** - Larger, visible algae can be found in freshwater, terrestrial, or marine environments. If the plant body is attached to the substrate, part of the substrate should be detached with the plant. Dried specimens can be made by floating the specimens onto a stiff

sheet of paper, and then covering them with a non-adhesive layer (such as cheesecloth or wax paper) to stop the paper sticking to it during subsequent pressing of the specimen.

## 4 Field notes and observations

Observations should be noted down at the time of collection and should include locality information and details of the appearance of the living plant, since these are important for identifying the plant at a later time. Information on the habitat, frequency of the species, community type and associated species are important if the specimen is to be suitable for retention in a herbarium. At a later date this field information will be copied onto a label that is attached, with the specimen, to a herbarium sheet.

When collecting more than a few specimens, it is necessary to assign a number to each collection and record the corresponding field notes in a notebook. At the time of collection, a tag should be attached to the specimen with a number corresponding to the number in the fieldbook.

A field notebook should contain the following information to ensure that all the relevant field notes are taken.

- 
- field name
  - Scientific name:
  - Family:
  - Collector:                      Collection number:                      Date:
  - Location:
  - Latitude:                      Longitude:                      Altitude:
  - How common: (e.g. dominant, localized, occasional, rare)
  - Habit: (e.g. tree, shrub, herb or climber)
  - Height:
  - Flower colour:
  - Fruit colour:
  - Landform: (e.g. steep or gentle hillside, ridge top, creek bank, etc.)
  - Rock/soil type:
  - Surrounding vegetation:
  - Other comments:
- 

Information should include the locality (the distance and direction from a well-known landmark or town should be given) and if possible the latitude and longitude of the site (from a topographic map or by using a global positioning system (GPS)), collector's name, date, the size of the plant, and the colour(s) of the flowers or floral parts and leaves when fresh. Notes should also indicate whether the plants were cultivated, or grew in natural vegetation, disturbed sites, or pasture. It is desirable to note the altitude, rock or soil type if known, and to describe briefly the habitat (e.g. in eucalypt woodland on dry sandstone ridge; moist grassy site near river bank; rooted in gravel, in water 30 cm deep, in fast-flowing stream). The names or specimen numbers of plants in surrounding vegetation may be noted.

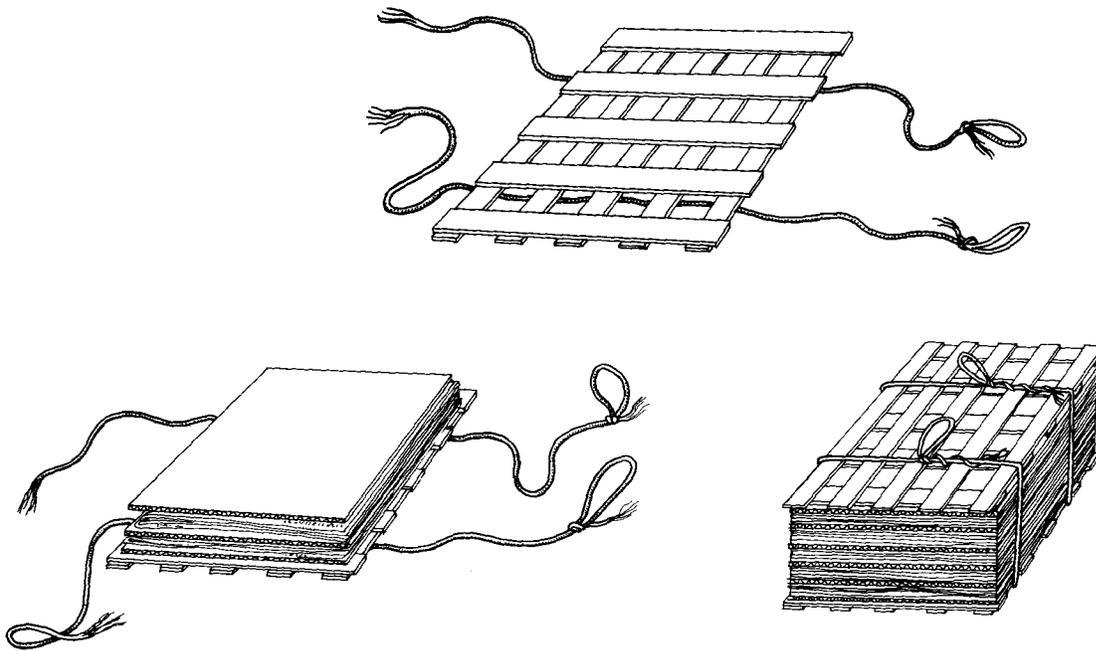
Photographs of the whole or part of the plant may be used to supplement the information included in the notes. Colour prints or slides are useful to record the colour of the flower, fruit and any unusual colouring in the leaves or stems. If a photograph is taken, this should be recorded in the fieldbook.

If additional material (e.g. photos, seeds, wood, spirit collection) is collected, it should also be numbered with the same collection number as the specimen. The collection number may be

written directly onto wood samples with a felt-tipped marking pen. As previously mentioned, numbers for material in liquid preservative (e.g. alcohol solution) should be written in pencil on a small piece of paper (as many inks are alcohol soluble) and placed in the container; an additional label on the lid or exterior of the container is advantageous.

## 5 Pressing and drying specimens

Specimens are best pressed as soon as possible after collection, before wilting and shrivelling occurs. Most plants may be kept in sealed containers such as plastic bags for up to a day if it is not convenient to press them immediately. If specimens need to be kept for longer periods, or if the conditions are very warm, plants should be placed in an esky or refrigerator. However, some plants show such rapid wilting, particularly of the flowers, that any delay should be avoided as far as possible. Specimens are pressed flat and usually dried between sheets of semi-absorbent paper such as newspaper. Papers with a glossy surface should be avoided because they are not sufficiently absorbent to aid drying. The plants should be carefully laid out between the sheets as their form at this stage largely determines their final appearance. The flowers should be spread out with the petals carefully arranged, wilted leaves should be straightened, and unnecessary shoots of excessively twiggy shrubs may be cut away. Leaves should be placed so that both the upper and lower surfaces are visible on the specimen. Flowers with copious nectar may go mouldy very quickly if excess nectar is not shaken off before pressing.



Pressing plants in a plant press between sheets of newspaper and cardboard.

Sheets of thick, preferably smooth-sided, centre-corrugated cardboard (such as used in cardboard carton sides), placed between the drying papers will assist air circulation through the press. These are particularly necessary when using forced circulation of warm air. If such cardboard is not available, additional sheets of newspaper or wooden board (e.g. plywood) may be used to absorb moisture from succulent specimens.

When plants are uneven in thickness, for example where flowers are borne on thick twigs, or arise from a thick bulbous base, sheets of spongy plastic foam (polyurethane or similar) about 1 cm thick, placed between the newspaper folders, help to distribute pressure evenly across the specimen. If foam sheets are not available several thicknesses of folded newspaper may be used.

Care must be taken to ensure that damp spots do not develop in the press. When using foam sheets it is advisable to circulate warm air around the press, or change the drying papers more frequently.

Specimens are best pressed with moderate pressure, preferably in an arrangement that will permit as free a circulation of air as possible. This can be achieved by strapping the pile together in a press, that is, between frames made, for example, from sheets of heavy (non-bending) cardboard, hardboard, plywood, pegboard, or best of all, a lattice of wood or metal strips (e.g. weldmesh). Supplies of suitable materials can usually be obtained from packaging and cardboard manufacturers, who will cut materials to suitable sizes, or from hardware or building suppliers. The press frames should be the same size as, or a little larger than the drying papers. Amateur collectors often press small numbers of specimens by placing books or other weights on the pile of specimens, but this is not recommended as specimens quickly go mouldy without air circulation.

The papers should be checked for dampness, and changed when necessary. As the number of changes required will vary with the original succulence/ water content of the plants, and with the weather conditions, no exact guide can be given. Most plants should dry in less than ten days. For the first few days the paper should be changed daily, but after that time the frequency of changes needed depends on conditions and relative humidity (RH) levels. In tropical and wet conditions daily changes will be necessary throughout the drying period, but in drier conditions the last one or two changes need only be made at intervals of three or four days. Used paper should be discarded, or thoroughly dried again before reuse.

When collecting in the field for an extended time, drying can be aided by placing the pressed plants in a warm sunny position during the day. In reasonably dry climates, drying is aided by securing the presses to the roof rack of the vehicle while driving in dry daytime conditions. If available, a hot-air fan directing air around the press will assist drying. Drying cabinets with a forced circulation of warm air are used in large herbaria to shorten drying time and to lessen the need to change drying papers, but these are not necessary for small quantities of specimens.

A few species regularly turn black on drying, but in general, brownish or blackish colours in the completed specimens, or the growth of fungi, indicate that drying was too slow, often because the papers were not changed frequently enough in the early stages of drying.

### **5.1 *Microwave ovens***

Small numbers of specimens can be dried using some types of microwave oven. It should be noted that microwave treatment damages seeds and the cellular structure of the plants, and may reduce the long-term value of the specimens.

It is best to place the specimens between unprinted absorbent paper such as butcher's paper. Newspaper is unsuitable because the chemicals present in the ink may cause the paper to ignite. The specimens should be put in a special press that should be of a microwave safe material (wood, acrylic or polycarbonate sheeting, e.g. plexiglass or Perspex; no metal components). If such a press is not available, sheets of cardboard can be placed above and below the specimens and then weighed down. Drying time depends on the power of the oven. In most cases drying is accomplished by irradiating at maximum power for 1- 2 minutes per specimen, although it is often a case of trial and error. It is best to process no more than 10 -12 specimens of average thickness per batch. Specimens are usually dried after the moisture that characteristically appears on the glass door has disappeared. If the specimen is damp when taken out of the oven, allow it to stand before re-irradiation as moisture will continue to evaporate from the specimen for some time. Care must be taken not to irradiate the specimens for too long.

## **5.2 Special processing treatments**

Some plants, and certain climatic conditions require the use of special processing treatments. A brief summary follows.

**Orchids** - Particular care is required when pressing orchids, owing to their delicate flowers. The flowers (at least one) should be spread out evenly so that the flower parts face the paper surface without creases or folds (never allow the parts to fold up or stick together). Alternatively, cut off each organ of a flower (three sepals, two lateral petals, a lip petal and the column attached to the ovary), spread these parts on the same piece of paper, and then press them. A superior method is to pickle the specimen in a bottle containing 70% alcohol or methylated spirits. Label the jar clearly with the preservative used. Colours will fade quickly in spirit so it is a good idea to keep comprehensive notes and photographs.

**Large algae** - Large algae can be kept for a day or so, but it is preferable to dry specimens as soon as possible. If very soft or filamentous, such plants may be best arranged on the mounting sheet while in a shallow dish of water. First the mounting sheet is placed into the dish and then the specimens on the sheet are gently slid from the water. Because such specimens tend to adhere to the drying papers they are best pressed between a mounting sheet (to which the lower side of the specimen may remain permanently attached) and a sheet of adhesion resistant material (such as wax paper or cheesecloth) to prevent the upper side of the specimen adhering to the drying papers.

**Water plants** - Specimens should be carefully laid on a sheet of paper, excess water removed, then pressed and dried in the normal manner. Very soft water plants may require special treatment such as being floated onto a sheet of paper while immersed in water and then dried (as is usual for marine algae) or preserved in alcohol or formalin solutions.

**Succulent plants** - Plants such as cacti, figs (species of *Ficus*) and mistletoes drop their leaves entirely upon drying, or remain alive for an excessively long period in the press. This is overcome by killing the plant before pressing, either by freezing the specimen for a few hours, dipping it in boiling water for a few minutes, or using a microwave oven. The correct time in a microwave oven depends on the type of oven and the specimen itself, but is usually about 2 minutes. Succulent material is 'done' when it has a flaccid, water-soaked appearance.

When the cell tissue has been killed (by freezing, scalding or irradiation) the specimen will still require special attention until it has dried completely. The papers must be changed at least daily for the first few days, and complete drying in the case of cacti may take more than a month. An alternative technique is to collect succulent material in 70% alcohol, as this preserves its original shape.

**Bulky or large specimens** - Bulky spikes or inflorescences of banksias (species of *Banksia*) or waratahs (species of *Telopea*), thistle heads or waterlilies should be cut or sawn lengthwise before pressing. Large and/or succulent fruit are often best preserved by cutting both lengthwise and crosswise, and drying these portions. Care is necessary to ensure that as much information as possible is retained from the specimens and is available for these sections.

**Tropical conditions** - High humidity in tropical and coastal conditions requires the adoption of special methods to prevent rapid growth of fungi before the specimens can be placed in drying cabinets. A method commonly adopted is to place the entire bundle of drying papers and specimens in a plastic bag and adding a small quantity of ethanol (enough to saturate with vapour). This is sometimes called the Schweinfurth method, after an Austrian botanist who

collected extensively in tropical areas. Such methods alter specimen colours and should be avoided unless conditions make them essential.

## **6 Mounting and labelling specimens**

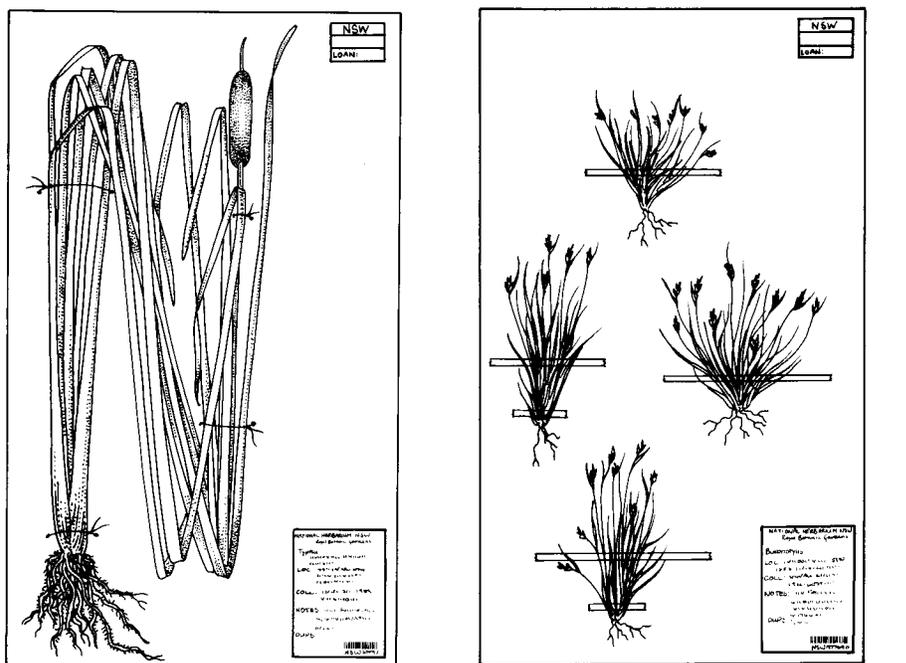
Mounting of specimens decreases fragmenting of most fragile material and prevents specimens becoming separated from their labels. If the plant collection is a long-term project, specimens should be mounted on sheets of archival (permanent) cardboard or paper that are usually about 43 cm long x 28 cm wide. Specimens should be attached to the sheets with archival-quality tape or thread.

Dental floss can be used for bulky or woody specimens by puncturing the sheet on either side of the specimen, threading the floss through, and tying ends together in a simple reef knot. Attaching specimens by tape is the easiest and quickest method. It also has the advantage that the tape is easy to remove if the underside of the specimen needs to be examined. Long-lasting 3M tape (Y8440) is archival and is available as a special order from 3M ('Scotch' brand) distributors. This tape has been in use in some Australian herbaria for over 15 years with good success. Ordinary adhesive tapes are unsuitable as the adhesive breaks down, becoming tacky and detached, after a few years. Small pieces of material that may have become separated from the specimen (e.g. seeds) can be placed in small plastic bags and pinned to the sheet.

One disadvantage of mounting specimens is that it can make parts of the specimen inaccessible for examination, so it is essential that this be borne in mind during specimen arrangement and mounting. For example, easily reversible mounting media should be used, specimens should be strapped to the sheet, rather than glued all over, and the specimen should be carefully arranged before it is attached so that it shows all features.

Several points should be kept in mind when mounting specimens:

- Do not tape over flowers or small fruits.
- Remove any loose soil from the underground organs.
- Leave sufficient space on the lower right-hand corner for the specimen label.
- Arrange the specimen to display as many features as possible, for example upper and lower leaf surfaces, and inner and outer aspects of flowers.
- Arrange larger specimens diagonally across the sheet, or place them in a V, N or M form if they have been pressed in that particular shape.
- For small plants it is usual to mount more than one on a sheet. If so, distribute them evenly on the sheet with the largest towards the base.



Large and small specimens mounted on herbarium sheets.

The plant name and notes should be written on a permanent label fixed to one corner of the herbarium sheet (the bottom right-hand corner being the most common) or sometimes annotations may be written directly on the sheet or card. Cards 20 cm x 13 cm are a suitable size for personal reference sets of identified materials but are unsuitable for research collections.

Details contained in the field notebook should be copied onto the label. Now that most larger herbaria are databasing their collections, it is usual for their labels to be generated by computer. A basic label can be printed or photocopied and would have the following information:

**NATIONAL HERBARIUM OF NEW SOUTH WALES (NSW)**  
**Royal Botanic Gardens, Sydney**

*Telopea aspera* Crisp & P.H.Weston

det. D.C. Godden May 1991

PROTEACEAE

**Loc.:** 10 m off track on the right hand side of track to Dandahra Needles, above Little Creek, c. 500 m from Mulligan's Hut, 9.3 km from Ranger's Station on Gwydir Highway,

Gibraltar Range National Park.

AUSTRALIA NSW N. Tablelands  
 Lat. 29°31'S Long. 152°19'E Alt.: 900 m.

**Coll.:** D.C. Godden 173 & K.L. Wilson **Date:** 09 May 1991

**Notes:** Gentle W facing slope above creek. Disturbed open dry sclerophyll woodland with *Acacia* spp., *Pteridium*, *Eucalyptus* spp., *Lomatia* and *Banksia spinulosa*. Granite with quartz.

Locally occasional. Woody multi-stemmed shrub to 2 m high. Fruit orange-pink.

**Dups. to:**



NSW240024

Computer-generated label for a specimen of *Telopea aspera*

The information on this label is given under basic headings. The barcode and the NSW number (NSW240024) enable more efficient management of the specimens. As well the barcode enables the information on the label to be electronically entered into a list by wandng the code. When a specimen is cited in a publication, the unique NSW number may be given. (All major herbaria of the world have a designated abbreviation or acronym, and that acronym for the National Herbarium of New South Wales is NSW.)

## **7 Storage and preservation**

The long-term preservation of dry plant specimens is largely dependent on the conditions under which the specimens are stored, and the protection afforded from insect and fungal attack. Specimens collected by Linnaeus in the eighteenth century, and by Banks and Solander on the *Endeavour* voyage along the east coast of Australia in 1770, are still excellently preserved in herbaria.

It is best to treat the specimens before they are incorporated into a collection, in order to kill any living insects that are on the material. Freezing is expected to kill insect eggs and spores. Since any such treatment used may not kill all eggs or spores that may be present, it is necessary to maintain the collection under conditions that will prevent the reinfestation or growth of any organisms that may damage the specimens.

### **7.1 Storage and filing**

Specimens are stored and filed so that they can be referred to and retrieved easily. The method used for storage will depend largely on the size of the collection and its purpose. Specimens should be stored in relatively low humidity (below 50%) and constant temperatures around 21°C to discourage the growth of fungi and infestation by insect pests. Dried and pressed plant specimens may be stored in cardboard or plastic boxes, or in bundles in lightweight cardboard folders placed in 'pigeon holes'. Alternatively they can be placed in protective plastic jackets and displayed in ring folders - this form of storage is recommended if they are to be handled frequently, such as in a reference collection. Small reference collections (such as on 20 x 13 cm cards) can be stored and handled easily if filed in a card cabinet.

Large, unpressed specimens (such as cycad cones or palm leaves) are often difficult to store and protect from reinfestation by insects. Large boxes or plastic bags should be used and then placed on shelves or in drawers.

Wet or spirit collections at times can be more difficult and cumbersome to store. If the material is preserved in small jars or Macartney bottles they can be kept in card cabinets, while larger jars can be arranged on shelves or in boxes. Over time, solution from the containers tends to evaporate, so the solution will require topping up from time to time.

Specimens should be filed in a systematic order if a relatively permanent collection is being made. The major groups, that is, mosses and liverworts, ferns and fern allies, cycads and conifers, dicotyledons and monocotyledons, are best kept separately. Within these, the families may be arranged alphabetically, or according to a classification scheme, such as that given in a flora or handbook. Similarly, the genera within each family, and species within each genus, may be filed alphabetically or following a published classification system. Specimens are often easier to locate if arranged alphabetically, though there are problems when plant names are changed and taxa have to be rearranged to accommodate them. If specimens are arranged according to a classification system it is necessary to have a readily available list to provide the sequence in which the taxa have been arranged, and to indicate which system is being used.

## **7.2 Pests and their control**

The most effective means of control of pests is prevention through regular inspection, good housekeeping and regular maintenance of the collection. A range of factors may cause deterioration of dried plant material. The most common causes of deterioration are insects and fungi, though rodents and other large animals can cause damage in poor storage conditions. Insects eat the material, the paper surrounding the material, and the adhesives and mounting media. Such insect pests range from psocids (book lice) that attack mainly the softer parts such as flowers and soft fruits, to tobacco beetles (often referred to as herbarium beetles) and carpet beetles, that can bore holes through the toughest of specimens. Many insects are particularly sensitive to levels of relative humidity and do not thrive at levels below 50%.

Specimens should be treated before they are taken into an established plant collection so as to avoid the introduction of pests. The most common and acceptable specimen treatments for insect control are discussed below.

**Freezing** - This technique is the least dangerous to human health and is very simple. The specimens must be frozen to  $-18^{\circ}\text{C}$  or colder, and kept at that temperature for at least 48 hours. In practice, when specimens are frozen in domestic deep-freezers in bulk and/or in boxes, it is necessary to freeze them for 72 hours (3 days and 3 nights) to ensure that the centres of thick specimens and specimens in the middle of large bundles are reduced to a low enough temperature for long enough time to kill all pests. Bundles of specimens should be sealed in plastic bags before freezing, to avoid moisture condensing on the sheets as they thaw and return to room temperature.

**Microwave** - Specimens may also be treated in a microwave oven to kill any animal life present on them. Microwave treatment is a fast method for small numbers of specimens. The technique is similar to microwave drying of specimens except that a press is not essential for already dry material and times may be reduced from those required for drying. No absolute guidelines can be given as it is best to use trial and error testing for each set of circumstances and different types of microwave, but times of 1-2 minutes per dried plant specimen should be adequate. *Note:* mounted specimens should not be placed in microwave ovens as the adhesives often melt and the tape may ignite.

**Poisoning** - A traditional method of insect control was to poison the specimens with a chemical to make them unpalatable or deadly to pests. However, this is not recommended, owing to obvious health risks. Domestic spray-type insecticide is of limited effectiveness and (to avoid staining) should not be sprayed directly on mounted sheets. Sprays may kill surface insects but, for instance, would not penetrate to insects living near the centre of a *Banksia* infructescence or cone. Many spray insecticides are now regarded as possibly detrimental to human health, so health and safety should be carefully considered before they are used. It is essential that specimens that have been poisoned be so identified, both to warn users of the health risks involved and to avoid misleading any later chemical research using the specimens.

## **7.3 Insect deterrents**

After the specimens have been incorporated in a collection and stored in boxes, cabinets or folders, it is necessary to take great care to stop them from being infested by insects. These insect threats may be from the surrounding atmosphere or from eggs in, or on, the plant material. In the past a number of chemicals have been used as insect deterrents, but most of them have been found to have some adverse effects on those working closely with the specimens. In most

instances it is recommended that good housekeeping in conjunction with a relatively low humidity and regular monitoring should be more than adequate to stop insects from infesting and damaging the specimens. If there are any signs of insect damage to the specimens they should be frozen for 72 hours.

Naphthalene (commonly found as moth balls) was probably the most frequently used chemical in herbaria because of its reputation for reasonable effectiveness in insect control, coupled with low toxicity to humans. When used as an insect deterrent the levels around specimens had to be maintained at a steady, high level to ensure effective insect control. Such high levels of naphthalene, however, may be harmful to people using the collections.

It should be noted that naphthalene is poisonous if ingested naphthalene dust can cause eye health problems for people with contact lenses, and chronic high levels of exposure are believed to be implicated in the formation of cataracts. Naphthalene vapour may cause eye and skin irritation and dermatitis in sensitized individuals, and headaches if used in poorly ventilated areas. There are reports of possible carcinogenic effects at very high concentrations, but current information indicates that naphthalene is neither a carcinogen nor mutagen (Dawson, 1992). Naphthalene, if left loose in specimen containers or boxes, is more readily inhaled or ingested and is more likely to cause problems to people with contact lenses than naphthalene in block or ball form. It is important to wash one's hands after handling specimens, that have been in contact with naphthalene, and to use tongs when handling naphthalene blocks. Therefore, with these current concerns over any possible health problems, naphthalene is not recommended as a suitable insect deterrent.

#### **7.4 Fungal pests**

Fungal attack is mainly a danger to damp specimens, either through incomplete drying during specimen preparation, or collections becoming wet later through flood, other water damage or high humidity levels during storage. Properly dried plant specimens will not suffer from fungal attack if stored in the correct conditions, although freeze-dried fungal bodies such as mushrooms have been reported to be very susceptible to mould growth. Specimens with sugary exudations, or large quantities of nectar, are also particularly attractive to fungi and need special care during drying to ensure that they dry fast enough to prevent mould growth.

If fungus grows on the specimens, they can be brushed with alcohol or methylated spirits. However, this may alter the specimen unacceptably for chemical and other investigative research, and only kills the fungus present on the specimen; it does not correct the problems that allowed the fungus to develop. Specimens treated for fungal (mould) attack should be clearly annotated as such, including date and treatment given.