Collecting and preserving plant specimens, a manual

Queensland Herbarium

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Why collect ?

Herbarium specimens are used for a variety of purposes, they

- allow and support accurate identification of plants, algae, lichens and fungi
- provide a permanent record for a species at a particular time and place
- form the basis of reliable distribution maps for plant taxa
- provide the basic biological material for taxonomists and other researchers
- document the spread of invasive weeds
- are the reference point for the application of the scientific names
- serve as vouchers for seed collections, taxonomic and ecological research, and biochemical analyses.

The importance of lodging **voucher specimens** of study taxa cannot be over-emphasized. These voucher specimens are invaluable for verification of the identity of the study taxon. If lodged in a recognised herbarium, they will endure in the collection for many years. This means that research and survey data will remain current and useful many years after the event, especially when names and taxonomies have changed. The herbarium specimens can be checked and verified at any time from the voucher reference in the publication.

Before you collect

Permits

Before going on to private land you must request permission from the owner to access and traverse their land.

Collecting specimens in National Parks and State forests is illegal unless you have a permit. Permits to collect for scientific purposes can be obtained from www.epa.qld.gov.au/ecoaccess/plants_and_animals

Safety

Protective equipment

It is advisable to take personal protective equipment such as sunscreen, a hat, long-sleeved shirt and long trousers, sturdy shoes, a first-aid kit, water and food on any collecting trip. Make sure you have additional suitable equipment as required for the particular job. For example, gloves will be needed handling prickly, sappy material, and a hard hat for collecting material from trees (see list of equipment on next page).

Safe travel procedures

Always let someone know where you are, and when you expect to return. For prolonged journeys, details of your intended route and destination, call-in procedure and expected time of return should be left with someone who can raise help if necessary. Always travel with someone and discuss safety issues before you leave. Always make sure that the vehicle is suitable for the job, and functioning properly prior to leaving. All safety equipment such as satellite phones and recovery gear should also be checked prior to leaving.

Commonly used equipment

For general collecting you will require

- a day press that is light enough to carry around. This should include only a few cardboard corrugates, and a few dozen sheets of newspaper.
- a field press with many more corrugates and more newspaper. This can be left at the campsite, accommodation, or in the car.
- spare corrugates and newspaper and some sheets of foam for bulky items
- secateurs to cut and trim specimens
- GPS for recording an accurate latitude and longitude. Alternatively, mark the position on a topographic map.
- a field notebook and pencil. This can be a pocket-sized notebook or a book of pre-printed specimen labels may be used.
- large and small plastic bags, to hold specimens temporarily
- small brown paper bags for collecting fruits, seeds, bryophytes and lichens and seeds that may fall off during drying
- a hand lens
- gloves, for handling prickly plant material or plants with corrosive sap
- tie-on tags, often called jewellers tags
- felt tipped pens and pencils for numbering collection and writing notes.

In addition you may require

- a trowel for digging out herbaceous plants with underground structures. For example, *Haemodorum* species have bulbs 15-20 cm below the surface and *Murdannia* species have tubers that will be left behind if you pull plants from above.
- plastic bottles with preserving liquid, to preserve fleshy plants or delicate flowers. This usually consists of 70% alcohol. Note: alcohol **cannot** be sent by mail.
- a camera for photographing the form of the plant, flower colour and its natural habitat. Photographs should be linked to a specimen voucher so that the plant names can be kept up-to-date in the future.

For collecting specimens from trees you will need

- a throwing rope
- a hard hat
- binoculars to help you locate the optimum material.

Selecting the plant material

Select vigorous, typical specimens. Avoid insect-damaged plants. Collect at least two sets of specimens (duplicates) and number each set. Keep one set for your reference, and send the duplicate set to the Herbarium for identification or as a voucher if required. The Queensland Herbarium does not return specimens.

A good specimen includes underground parts, stems, leaves, flowers and fruits. Basal parts of grasses, sedges, ferns and bulbous plants are essential for identification.

The plant material should be fertile i.e. in flower or fruit (both if possible), as these characteristics are often vital for identification. Some time should be spent looking at a number of individuals, and choosing the one with a number of flowers or more mature fruits.

Choose individuals that show the variation in leaf, flower and fruit size. It may be important to show morphological variation, involving the collection of individuals of different sizes.

Collection of sterile material is acceptable for

- bamboos
- rainforest plants. Flowers and fruits are often very difficult to obtain in the rainforest but sterile material can usually be identified.
- some aquatic plants, for example Lemnaceae
- juvenile plants of a known species
- perennial weeds, as a record of naturalisation.

Size of the specimen

A specimen should ideally be 25-40 cm long and up to 26 cm wide, allowing it to fit on a standard herbarium mounting sheet which measures 42 x 27 cm. Conveniently, this is also the approximate size of newspapers.

Plant parts that are too large for a single sheet may be cut into sections pressed on a series of sheets, for example a palm or cycad frond.

Long and narrow specimens such as grasses and sedges can be folded once, twice or even three times at the time of pressing. In this way a plant of up to 1.6 metres high may be pressed onto a single sheet.

For very small plants, a number of individuals may be placed on each sheet.

Features of the plant

When collecting from trees or large shrubs, distinctive or notable features should be recorded, for example branching habit, details of the bark and height and width of the plant.

You may need to collect more than one specimen to show the range of variation that is present, for example mature and immature parts, juvenile and adult leaves, coppice shoots.

If the plant is dioecious, with male and female flowers on different plants, collect from each plant and label the specimens A & B.

Handling plants during collection

For best results, specimens should be pressed within a few minutes of being removed from the plant. Many species wilt and fade soon after collection.

If specimens cannot be pressed at the point of collection, for example if it is raining or on steep terrain, they may be stored in large plastic bags. The bags should be kept moist, and the specimens not jammed in too tightly. Make sure that each bag is correctly labelled, using one bag per collection site. However, **storing specimens in plastic bags is not recommended** because it is easy for specimens to become damaged or mixed.

Step-by-step procedure for plant collecting and pressing

FIGURE 1. Find a specimen that is representative of the existing population. Collect both flowers and fruits if available.

FIGURE 2. Use secateurs for a clean cut of the stem. Collect two specimens if you wish to retain one sample for yourself.

FIGURE 3. Specimens should be pressed as soon as possible after they are removed from the plant.

FIGURE 4. Have plenty of newspaper on hand for pressing.

FIGURE 5. Undo the webbing straps to the plant press and open your plant press.

FIGURE 6. Corrugated cardboard in your press is useful to separate specimens and provide a firm flat surface for the specimen to be pressed against. The corrugations also allow air to circulate, thus enhancing the drying of the specimen.

FIGURE 7. Every specimen (and its duplicates) should be tagged using jeweller's tags. Write your name (or initials) and collection number for the specimen on one side of the tag. The date and site number may be written on the other side.

FIGURE 8. Attach the tag onto the specimen.

FIGURE 9. The specimen is placed inside the folded newspaper.

FIGURE 10. If the specimen is too large, trim it by cutting, or bend it back.

FIGURE 11. Consider how the mounted specimen will appear. Its form at this time largely determines its ultimate appearance. Unnecessary twiggy shoots may be cut away.

FIGURE 12. Spread the specimen out to show all the parts. Open some flowers and turn others over to show all surfaces. Both upper and lower surfaces of the leaves should be visible.

FIGURE 13. Fold newspaper over the specimen and place on top of corrugated cardboard. Sheets of foam rubber can be used to assist the successful pressing of bulky specimens.

FIGURE 14. Finish with another corrugated cardboard and the second wooden lattice frame.

FIGURE 15. Arrange webbing straps properly and then pull the straps tight so that your specimens are pressed under moderate pressure.

FIGURE 16. All notes about the plants should be recorded in the field when the plant is actually collected and not at a later time.

FIGURE 17. Record site/habitat data (locality, GPS co-ordinates, soil/geology, vegetation type) and individual specimen data (habit, flower colour, abundance) on a label or in a notebook.

FIGURE 18. Example of a herbarium specimen, *Hymenachne amplexicaulis.*

Data to be recorded in the field

Many botanists use a small notebook to record information about the specimens they collect, and the sites at which they collect them.

The following information should be recorded **before you leave the collection site**, otherwise the chance of giving erroneous information is greatly increased.

1. A preliminary descriptive locality. This can be modified later after consulting maps, but the preliminary locality reminds you about which site it is.
2. GPS location. This can be recorded as lat/long or AMG. Remember to also record the datum that you are using.
3. Habitat (site) data, including landform, slope, dominant plant species, structural formation, for example “open forest”, “open woodland”, “shrubland” or regional ecosystem. Soil type and geology should be added if known. Record whether the collection site was a disturbed site such as a roadside, burnt area or grazed paddock.
4. Information about the individual species collected at the site, particularly height, form, presence of rhizomes, presence and colour of sap in cut stems, colour of new growth and flower colour. Flower colour often changes on drying. Also record the relative abundance of the species, particularly for weeds.

Drying specimens

It is essential to dry the specimens fairly quickly, to prevent to onset of fungal attack. Fungus affected specimens are of limited value to a Herbarium.

If your field trip involves car travel, specimens placed in presses on the roof rack will dry within a few days if the humidity is low.

In a very warm and humid place, the damp papers and corrugates should be replaced daily. In drier inland areas, every 2 or 3 days will suffice. After changing the papers and corrugates, the specimens should be again tightly packed in the press, otherwise they will not remain flat.

At the first paper change, adjust any undesirable features of the specimen, for example folded leaves, leaves all showing the same face, flowers obscured by leaves. Such adjustments will not be possible once the specimen has fully dried. Look for any evidence of insect attack, especially caterpillars in flowers, and remove any insects found. Insects can also hatch after collection and quickly destroy flowers.

Drying in the field

Placing the presses in the sun during the day appears to have little drying effect except for the topmost and bottommost specimens. However, the sun is invaluable for drying the damp papers and corrugates once they have been removed from the press.

Collapsible field driers are useful in remote areas. Typically these consist of an outer metal frame, a wire grid where the press sits, on top of a gas burner on very low flame.

Drying when based in a powered building

A fan heater (set on the lowest heat) will assist drying, provided you ensure the air is directed towards the press and has free access through the gaps in the corrugates. Placing specimens near an air conditioning unit will also assist with the drying process.

Some species tend to fall apart when made into a specimen, usually the leaves detach from the stem. This especially applies to specimens of *Erythrina, Ficus*, Loranthaceae, and mangroves. Leaf detachment can be prevented by dipping the newly pressed specimen in very hot water for 15 seconds, or placing it in a microwave oven for a similar time.

Writing a final label to accompany the specimen

The data that accompanies a herbarium specimen is just as important as the specimen itself. Even a very good quality specimen is of no use to a Herbarium unless it has a written label with the information detailed below.

Collector's name: [mandatory] the name(s) of the person/people who collected the specimen, preferably no more than 2 people. Don't include everyone who was on the trip.

Collector's number: [optional]

Date of collection: [mandatory].

Botanical name: [optional] your suggested name.

Locality: [mandatory] A written description of the collection locality is necessary, AS WELL AS a latitude and longitude reading. A GPS location alone is not sufficient. The locality description should be detailed enough to

enable any person to revisit the approximate place of collection. On the other hand, the locality description should not be too verbose and should not include information better included under "Habitat". Commonly, the description includes distance and/or direction from a town or a well known locality that is on a readily available map. It should be meaningful to someone not familiar with the local area.

*Here are some examples of a **good** locality description:*

W CLAUDIE RIVER, 10.3 KM WNW OF LOCKHART RIVER (GPS 12 44 38; 143 15 30)

JOHNSTON CREEK, 1 KM N OF MT ETNA (GRID REF 8951-389331)

INJUNE-ROLLESTON ROAD, 86 KM N OF INJUNE, GRID REF 8647 - 576145FN (ARCADIA MAP)

23.4 KM BY ROAD NNW OF PROSERPINE P.O. ON ROAD TO DINGO BEACH

15.8 KM S OF LAKE CARGELLICO ON RD TO RANKINS SPRINGS

*Here are some examples of a **poor** locality description:*

NOLAN CK [ambiguous]

ROCKHAMPTON [too vague]

LAURA-COEN [too vague]

SF64, PARISH OF CAMBOON, COUNTY OF DAWSON [maps giving this information not readily available; too vague]

POR 105 W OF COMP 5 ON POR 6 PARISH OF BULLI [maps giving this information not readily available]

SF144 [too difficult to establish where this state forest might be and where plant was collected]

548 KM N OF MT MOLLOY [locality should be given from a *nearby* town, in this case, Coen]

WIDBURY [no town mentioned]

Geocode: [mandatory] Transfer the GPS reading obtained in the field, e.g. Lat.: 35^{o} 26’ 43” S Long.: 135^{o} 17’ 29” E, AGD84; or determine a grid reference from map

Altitude: [optional]

Pastoral district: [optional] Refers to the Queensland Pastoral districts, for example North Kennedy, Moreton, Darling Downs

Habitat: [mandatory] Transfer the information from the field note book, for example “eucalypt woodland of *E. populnea*, regional ecosystem 11.3.2”.

Habit etc.: [mandatory] This information is transferred from the field note book, for example “spreading shrub to 2 m”.

Abundance: [optional] A comment on the frequency of the plant at the site where you collected it.

You may use terms such as "common" or "occasional", or you may give the actual numbers of plants. If you can’t distinguish individual plants then record the approximate area covered. This field is especially important for documenting the early spread of invasive weeds.

Other notes: [optional] Any other relevant information, for example a reference to a photographic image or material in spirit, ethno-botanical usage, or observed interaction with fauna.

References

Anon. (no date). Plant Collection Procedures and Specimen Preservation. Centre for Plant Biodiversity Research: Department of Environment and Heritage.www.anbg.gov.au/cpbr/herbarium/collecting/index.html [accessed 30 Jan 2006].

Bridson, D. and Forman, L. (1992). The Herbarium Handbook, revised edition. Royal Botanic Gardens, Kew: London.

Victor, J.E., Koekemoer, M., Fish, L., Smithies, S.J., & Mossmer, M. (2004). Herbarium essentials: the southern African Herbarium user manual. *Southern African Botanical Diversity Network Report* No. 25. SABONET, Pretoria.

Appendix 1. Collecting Weeds

Strict hygiene must be observed when collecting specimens of species listed as Declared under the *Land Protection (Pest and Stock Route Management) Act 2002* in order to prevent the further spread of these pests. Declared pest plants are listed on www.nrm.qld.gov.au/pests/weeds

Prior to travelling

Ensure that you have sufficient equipment and storage material for collecting and handling weed specimens. Include small and large sealable plastic bags (for dry material), dust pan and brush, and information on weed infested areas and wash-down facilities. A map of facilities can be seen on www.nrm.qld.gov.au/pests/weeds/weed_spread/washdown/facilities.html

Collecting your specimens

At the site, care must be taken to make sure reproductive material is not spread through the landscape by collecting activities. For example, seed heads may be collected separately (detached) and placed in sealed paper envelopes. Material that is already dry may be placed in sealed plastic bags.

Alternatively, where the reproductive material constitutes a large part of the specimen, the whole specimen may be sealed in a large paper envelope inside the press. Loose seeds and pieces should be placed in sealed envelopes, or discarded at the site of collection.

After you have pressed your sample make sure that reproductive material can't fall out of the press or storage box. At each site, the storage area should be swept prior to leaving. Make sure that you dispose of any excess collection material at the site of collection.

Before departing the site, remove any attached seeds and plant parts from your boots, clothing, and equipment. Vehicles should be thoroughly cleaned. This includes removal of mud attached to the wheel arches and chassis, soil or organic material in the foot wells (in the cabin), engine bay and recesses and storage areas. Consult the NRM&W checklist for cleandown procedures www.nrm.qld.gov.au/pests/weeds/weed_spread/pdf/cleandown_procedures.pdf

Transportation

When transporting high-risk material, the whole press should be transported in such a way as to prevent seed falling from the press. For example, the press may be placed in a plastic storage box while in transit, in such a way that still allows moisture to escape. Material should be carried inside the vehicle, and not on roof racks unless in properly sealed containers.

Processing and maintaining presses and specimens in the field

Processing of specimens in the field usually involves replacing damp paper with dry, trimming and tidying specimens and completing labels. These activities should be carried out in a clean area, preferably inside a building, and care should be taken so that all excess plant material, trimmings, used newspaper and envelopes and other loose bits are collected into sealed plastic bags, which are then disposed of appropriately.

When specimens are completely dry they should be double sealed in a plastic bag (one inside another) suitable for transportation or posting. Packages sent to the Queensland Herbarium should be clearly labelled with the name or suspected name and declared status of the species on the outside of the packaging.

References

Marchant, N., Gathe, J., & Lewington, M. (2001). How to collect and record weeds. Weed Information Network. *Western Australian Herbarium, Department of Conservation and Land Management, The Natural Heritage Trust.* Western Australia.

Appendix 2. Notes on the collection of some flowering plant families

Apiaceae: ripe fruits are essential

Asteraceae: collection of mature achenes (fruiting structures) is essential. Always ensure that at least some of the flowering heads are past flowering.

Brassicaceae: ripe fruits are essential

Cucurbitaceae: these species are often dioecious so correlated male and female collections are very valuable. Fruits are best placed in spirit and flowers in spirit are also useful.

Cyperaceae: ripe fruits (nuts) are essential and collection of rhizomes and/or tubers are recommended.

Lamiaceae: record the smell of crushed leaves

Leguminosae: mature pods are very important for identification. Some pods will shatter on drying. To catch seeds, place paper envelopes over pods in the press. Some legumes have underground pods or tubers. Dig out the plant and gently brush away the soil.

Loranthaceae: fruiting specimens without flowers cannot be identified. To prevent leaf-fall, dip material in very hot water or use a microwave oven, then dry as usual.

Myrtaceae: notes about the type of bark, or photographs of the bark are essential. Collect juvenile leaves of *Eucalyptus* and related genera where possible. Include new vegetative growth for *Melaleuca* and *Callistemon.*

Rainforest plants: flowers and fruits desirable but not essential. Collect branchlets with leaves *and* actively growing shoots from a plant as mature as possible

Orchidaceae: it is essential to place some flowers in spirit. Photographs are useful.

Poaceae: collect the whole plant, including roots, rhizomes or stolons

Solanaceae: fruits in spirit are highly desirable

Stylidiaceae: flowers in spirit are highly desirable

Appendix 3. Collecting difficult groups

Algae and mucilaginous water plants

Because these plants stick readily to newspaper it is best to prepare them as follows:

If small they can be floated onto a mounting sheet by lying the clean specimen in a tray of water and gently sliding the sheet underneath, then lifting it out with the specimen arranged appropriately on the sheet.

With larger plants such as water lilies, the specimen can be taken out of the water and carefully arranged on the sheet.

The sheet is then placed in a dry place to partially dry for perhaps a day. The specimen will be stuck or partially stuck to the mounting board.

Carefully press, preferably with waxed paper between the specimen and the usual newspaper.

Bananas (Musa spp.)

A good collection of a banana (Musa sp.) comprises herbarium sheets of pressed material, written notes, spirit material and photographs.

Portions to include on herbarium sheet:

- half lamina base + midrib, and upper section of petiole. Imagine the junction between lamina and petiole as forming the middle of the herbarium sheet. Cut off the top of the leaf, cut off the bottom of the petiole, and cut off one side of the lamina leaving the midrib intact, so that what remains will fit onto a herbarium sheet. One reference recommends collecting from the fourth-last fully developed leaf below the inflorescence.
- petiole base. Remove petiole very close to stem. Split petiole in half, longitudinally. Put both halves on a second sheet.
- one 'hand' of fruits. Include one fruit cut in longitudinal section
- one cluster of male flowers, attached to the subtending bract
- portion of the male peduncle (the hanging 'tail' between bunch and male flowers).

The reproductive parts should all fit on one sheet i.e. 3 sheets in total.

Layers of foam should be used to allow parts to press properly, and because of the bulky and moist reproductive parts (especially the fruits), some weeks in a specimen drying oven are essential for the successful production of the dried specimen.

Things to note on the specimen label: plants suckering freely or hardly suckering at all, colour of sap in suckers (watery, or red to violet, or milky), colour of pseudo-stem; older bracts strongly revolute or scarcely revolute, inflorescence erect or pendulous, total length of lamina and petiole, colour of fruit, colour of male flowers

Portions to include in spirit material: use a large screw-top glass jar. Include some male flowers, some female flowers, some fruits and a bract.

Things to photograph: whole plant, pseudo-stem (to show colour), whole inflorescence, bracts and male flowers.

References:

Argent, G.C.G. (1976). The Wild Bananas of Papua New Guinea. *Notes from the Royal Botanic Garden Edinburgh* 35: 77-114.

Fosberg, F.R. and Sachet, M. (1965) Manual for Tropical Herbaria*. Regnum Vegetabile* Vol 39.

Cacti and succulents

Preparation

Cut large flowers longitudinally or cut one side and open like a fan and flatten.

Make longitudinal sections and cross sections (about 1cm thick) of the stem. Include roots if possible. Keep aside some flowers and a piece of attached stem for a spirit collection.

Pressing

Press in the normal way with cardboard and newspaper and tie into a bundle. Put the whole bundle into a plastic bag and add 1-2 cups of alcohol. Seal up and leave for 24 hours to fume. Place the bundle in an airy position away from any source of flame. Allow it to ‘dry out’. Place bundle into drying oven.

Succulents can be treated as for cacti, or frozen for 24 hours. Once frozen, the papers initially need changing 2-3 times per day.

Note: specimens sent to the Queensland Herbarium for identification may be sent in the fresh state, in a cardboard box or something similar.

Cycads

Specimens will need to include a cone or at least a number of the sporophylls (scales) that make up a cone. Also include an entire leaf (i.e. the entire "frond", not just an individual pinnule (leaflet)) and an idea of how many leaves are present in the crown of the plant. As a leaf may be anything from 50 cm to 3 metres in length, they may be cut into c. 30 cm lengths for ease of handling.

Fungi

Try to collect a range of individuals from immature to adult, and record colours and substrate. Dig out the whole fungus, including the base of the stalk. Wrap in greaseproof paper or place in brown paper (not plastic) bag. A spore print is useful - cut off an adult cap (if present), and place gill-side down on a sheet of white paper; cover with a bowl or bucket for a couple of hours until the spores drop onto the paper. Photographs are essential.

Caution: Many fungi are toxic. Avoid inhaling spores. Wash hands after handling fungi.

Grass trees (*Xanthorrhoea*)

Note the lengths of the flowering and non-flowering parts of the spike ("spear"), and of the trunk (if any) below the leaves. The middle part of the spike (including the base of the flowering/fruiting portion and the top of the smooth portion) should be collected, as should a few complete leaves, including the leaf bases if possible. Be very careful not to damage the plant when collecting leaf bases; grass trees grow very slowly and may be a hundred or more years old.

Mosses, lichens and liverworts

Try to include fruiting bodies. These consist of tiny capsules or disks or "umbrellas" on stalks, or cupped to spherical appendages. Remove a few square centimetres of the plant mat gently from the substrate or, if adhering closely to bark, soil crust, or rock, cut or chip away pieces of the substrate with the plant in place. If the specimen is bulky or very wet, flatten it very carefully. Do not squash or press - place each specimen in a separate paper (not plastic) bag with a collection number and notes, and allow to air dry.

Palms (Arecaceae)

Record the label information on each piece with a tag. Photograph each entire part before sectioning. Place a common object such as a pencil in the photograph to provide scale.

Leaves

Measure the petiole, blade, rachis and leaflet lengths of pinnate leaves, the petiole and blade length of palmate (segments radiating from a single point) leaves and the petiole, blade and rib lengths of costapalmate (leaf stalk extending into leaf blade - rib) leaves.

1) If leaves are small, keep and press whole leaf.

2) For large leaves divide the petiole into mounting paper size pieces. Number the pieces on the tags to keep them in order of cutting.

   a) Pinnate leaf. Take several pieces from the blade. Include tip. For each piece, apart from the tip, cut the rachis into a mounting sheet size length, remove the leaflets on one side leaving the stubs near the rhachis. Fold the other side back and forth to fit the mounting sheet.

   b) Palmate leaf or costapalmate leaf. Keep the point of attachment to the petiole and ensure that the hastula is showing. Cut off one side of the blade, part of the other side and fold several times to fit the mounting sheet and press.

Inflorescence

If the flower cluster is small, fold and press all of it. If it is large, keep several portions including the base and also showing the origin of the side branches in successive order.

If applicable try to keep an entire inflorescence main stem with the side branches removed. Selected side branches from noted positions should be kept and pressed.

All of the spathe should be kept, cutting it into sections if necessary. Some flowers may be preserved in spirit.

Fruits

Fruits should be treated as for flowers. The cupule (or cup) at the base of the fruit should be kept. Large fruits may be dried quickly if cut in half.

References

Bailey, L.H. (1946) The Palm Herbarium. *Gentes Herb. Ithaca* 7 (fasc. 2): 153-180.

McCurrach, J.C. (1960) Palms of the World**.** Harper & Brothers, New York.

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Pandans (*Pandanus, Freycinetia*)

For details on collecting Pandans, see B.C.Stone (1983). A Guide to collecting Pandanaceae (*Pandanus, Freycinetia* and *Sararanga*). *Annals of the Missouri Botanic Gardens* 70: 137-45.