

***Documenting Ethnobotany* Master Class**

Post-Conference Handout

3rd International Conference on
Language Documentation and Conservation

1) Collecting Voucher specimens

The four chapters included this handout are from:

- Alexiades, M. (ed). 1996. *Selected Guidelines for Ethnobotanical Research: A Field Manual. Advances in Economic Botany*, vol.10. The New York Botanical Garden, Bronx.
- The first chapter includes excellent and detailed information on how to collect vouchers for botanical and ethnobotanical research in general. The second, third, and fourth chapters focus on the special cases of collecting palms, mushrooms, and bryophytes (mosses, liverworts, hornworts).

In addition, many websites have detailed information on plant collecting. The following are some good examples:

msuextension.org/publications/AgandNaturalResources/MT198359AG.pdf

- A step-by step guide by John Lacey, Sam Short and Jeff Mosley from Montana State University.

<http://www.flmnh.ufl.edu/herbarium/voucher.htm#Pressing>

- This website from the University of Florida museum (edited by Marc S. Frank and Kent D. Perkins) contains excellent information on collecting, pressing, drying, identification, making labels and mounting specimens, as well as a list of print/electronic resources for further information.

2) Locating herbaria where you work

sciweb.nybg.org/science2/IndexHerbariorum.asp

- This site provides a global directory of public herbaria and associated staff international herbaria.

3) Digital collections

www.tropicos.org

- All of the nomenclatural, bibliographic, and specimen data accumulated in the Missouri Botanical Garden's electronic databases during the past 25 years are publicly available here. This system has over 1.2 million scientific names and 4.0 million specimen records.

http://www.herbarium.hawaii.edu/cph_query/query/index.php

- The Consortium of Pacific Herbaria is in the process of digitalizing all specimens from herbaria in countries throughout Oceania.

<http://sciweb.nybg.org/science2/VirtualHerbarium.asp>

- The digitalized collection of the New York Botanical Garden. The digital collections comprise ~ 1,300,000 herbarium specimens and 225,000 high-resolution specimen images, and are updated daily as the Garden pursues the goal of digitizing all of its 7,300,000 plant and fungi specimens.

4) Recommend reading on traditional/local ecological knowledge

Berkes, Fikret. 2012. *Sacred ecology* (3rd edn.). New York, NY: Routledge.



4

Standard Techniques for Collecting and Preparing Herbarium Specimens

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Introduction

Properly collected voucher specimens of ethnobotanically important plants are essential for obtaining taxonomic identifications. In addition, voucher specimens provide a permanent record of information that can be reviewed or reassessed. Ethnobotanical information without adequately vouchered specimens has little scientific value, since vernacular names vary widely among individuals, ethnic groups, and geographical areas. Taxonomic determinations thus provide an important basis for systematizing ethnobotanical knowledge and serve as a critical link between folk and Western knowledge systems (Bye, 1986). This chapter summarizes standard techniques used to make herbarium specimens. For other discussions, readers may consult Archer, 1945; De Wolf, 1968; Fidalgo & Ramos, 1989; Fosberg, 1939; Fosberg & Sachet, 1965; Johnston, 1939; Kechledge, 1970?; Liesner, 1985; Mori et al., 1989; Savile, 1962; Smith, 1971; and Womersley, 1981. General discussions on managing herbarium collections and herbaria can be found in Forman & Bridson, 1989; Lot & Chiang, 1986; and Mori et al., 1989.

The Herbarium Specimen

Herbarium specimens are the main tools for taxonomic identification. In most cases, determinations will be only as good as the specimens on which they are based. Collecting sterile (lacking flowers or fruits), insufficiently annotated, or poor-quality specimens is a waste of time and space and, at best, will yield incomplete or unreliable determinations. Indeed, many taxonomists refuse to identify poorly made or sterile specimens. Well-pressed specimens on the other hand, provide much scientific informa-

A good herbarium specimen consists of a dried, pressed section of a plant containing well-preserved vegetative and reproductive (flowers, fruits) structures. Plant specimens are mounted for permanent storage on sheets of standard ragbond paper measuring about $11\frac{1}{2} \times 16\frac{1}{2}$ in. (28.7×41.7 cm). In the bottom right corner of the sheet there is a label containing information on the plant, a description of its appearance, and the area where it was collected. A small paper pouch attached to the herbarium sheet is used to keep small pieces of the specimen that might become dislodged with time, as well as extra flowers or fruits purposely collected (Figure 1). Herbarium sheets may also include photographs of the live plant or its parts, maps of the collection area, and hand-written annotations by taxonomists.

Collecting Specimens

Tools and Equipment

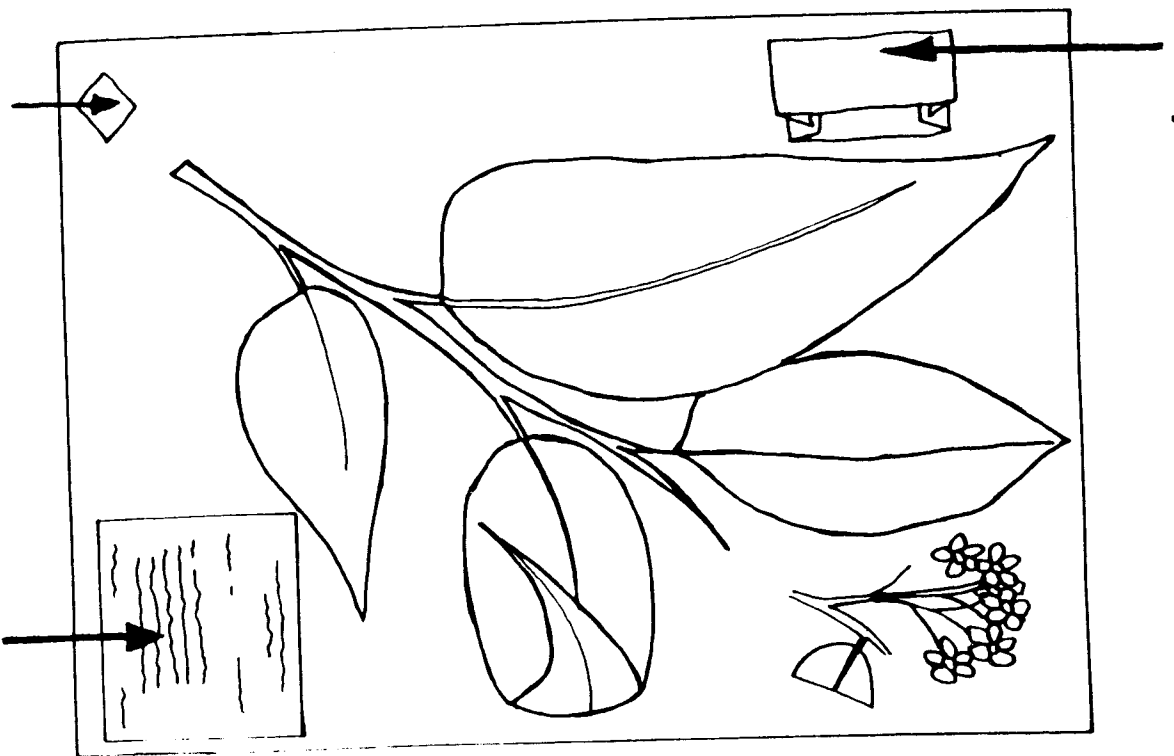
PRUNING SHEARS (GUPREK) These should be sturdy, of high-quality steel. Pruners are often carried in a sheath attached to a belt for safety and convenience.

BUSH KNIFE OR MACHETE A bush knife, known as *machete* in Latin America and *panga* in parts of Africa, is very useful for cutting trails through thick undergrowth and for cutting large branches, fruits, and so on. Longer blades allow delivery of more powerful strokes, but they also are harder to control and so are considerably more dangerous than shorter blades; a blade about 16 in. long is adequate for most purposes. Bush knives should always be used with extreme caution; they can easily inflict very deep cuts, especially if they are well sharpened. When cutting through vegetation, always swing the knife in arcs leading away from the body. Exercise caution, particularly when cutting through vines, because the blade can ricochet off a stem. When not in use, bush knives should be kept in a sheath.

FIELD PICK OR TROWEL Particularly useful for digging roots or removing the entire plant.

EXTENSIBLE TREE PRUNERS These consist of a number of telescoping or

Paper pouch



Institutional Stamp

Figure 1. The herbarium specimen.

Label

shears or a saw at the end. Telescoping poles can reach a maximum length of 12 m and are used for reaching the tree canopy. *Aluminum poles should not be used where there are any electric wires!*

Collection Notebook This should be sturdy, of good quality, preferably made of weatherproof paper, and with a waterproof slip-on cover. Weakly bound books or spiral bindings, which may allow pages to slip out or tear easily, should not be used. Some collectors keep their collection notebook safe at the base camp and use a pocket notebook to jot down notes while collecting plants.

Field Press In most cases it is best to arrange the plant specimens in newspaper in the field, carrying them in a field press. A field press usually consists of two 12 × 18 in. plywood or wood lattice frames, held together with a pair of cords or web straps 4 ft long (Figure 2). Some of the more portable models look like a satchel made of lightweight waterproof fabric.

Specimens are folded in old newspapers or unprinted newspaper stock and slipped between sheets of blotting paper or thin corrugated cardboard or aluminum. To save space, one can place several

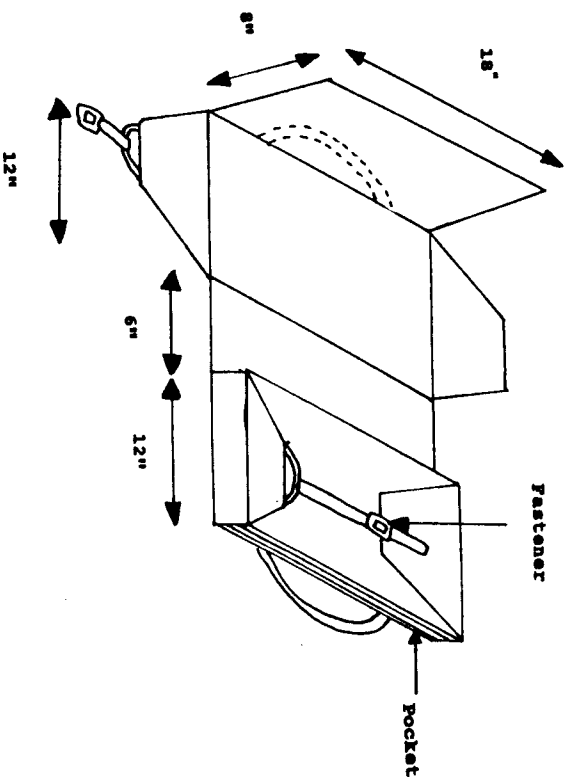


Figure 2. The field press.

newspapers with their enclosed plants between the corrugated sheets; a pair of rubber strands or cords hold the press together. Field presses are particularly useful when collecting few specimens, for transporting plants that wilt easily, and for small plants or fragile material that could otherwise be damaged or lost.

POCKET PRESS This consists of two pieces of cardboard, or an old notebook small enough to fit in a pocket, containing small sheets of blotting paper and held together by a strong elastic band. Pocket presses are used to collect delicate flowers.

NEWSPAPERS These are used for carrying specimens in the field press. Old newspapers or unprinted newsprint may be used, as long as they measure 11 × 16 in. or less; larger specimens will not fit in the 12 × 16 in. mounting sheet. Some tabloids are just the right size. Larger newspaper sheets may also be cut or folded to size.

LARGE, HEAVY-DUTY PLASTIC BAGS These may be used to carry the plant specimens to the base camp, where they can subsequently be pressed. Carrying plants to the base camp may be a good option when collecting time in the field is limited, when large amounts of material are collected, under extremely wet conditions, or when the plant material is sturdy enough.

SEALABLE PLASTIC, COTTON, AND BROWN PAPER BAGS (ASSORTED SIZES) Cotton or paper bags may be used to carry loose fruits and other fragile segments from the field to base camp. In some cases, the fruits can be dried in the same bags. Nylon net and cotton bags are ideal for storing fruits and plant parts after they have been dried. Plastic and, to a lesser extent, paper favor growth of mold. Sealable plastic bags can be used for transporting plant parts from the collection site to the base camp, as well as for a wide range of other purposes.

ALCOHOL Alcohol (70% solution or higher) is used to "pickle" fruits or flowers and to preserve bundles of plant specimens before drying. In many tropical countries, sugarcane alcohol can be obtained locally and cheaply.

PLASTIC WATERPROOF JARS These can be used to "pickle" fragile or rare

PAPER TAGS These are used to label nonpressed, loose plant parts in the field, as well as whole specimens collected in plastic bags. The most convenient are 1-in. tags with short cotton strings.

PENCIL OR WATERPROOF PEN A soft pencil or wax crayon can be used to label news sheets. Field notes should be written with a no. 2 pencil or with a pen with indelible ink. Collectors planning to use a pen to label news sheets that will be soaked in alcohol should ensure that the ink does not run.

GNOM Photographs can provide the specialist who will identify the plant specimens with valuable information on the plant's habit and the appearance of its parts. Furthermore, the photographs can be glued to the herbarium sheet, providing valuable information for future reference. Ideally, large leaves, such as those from some palms and ferns, should be photographed intact and next to a scale before they are cut into portions for pressing. A flash or tripod is needed for most shots inside the forest. When it is not possible to carry the camera to the field (during rainy weather or when collecting alone, for example), collected bulky plant parts may be photographed in the base camp.

MEASURING TAPE This is used to measure the diameter at breast height (dbh) of trees as well as large leaves and inflorescences that need to be cut up before they are pressed. Some forester tapes have both metric and dbh scales.

POCKET HAND LENS (10×) This is used as an aid in identifying specimens in the field.

MASKING AND DUCT TAPE Masking tape can be used to label specimens, tie packages, and so on. Duct tape is very useful for general repairs of equipment.

TREE CLIMBERS AND HAMMERS These are needed when herbarium collections must be made from trees whose canopy is inaccessible from the ground. *Tree climbing is dangerous and should be done only by trained personnel.* In many areas, it is possible to hire local tree climbers. There are types of equipment available for climbing trees, includ-

pers" (Mori, 1984, 1987), and mechanical ascenders (Perry, 1978; Perry & Williams, 1981; Whitracre, 1981).

Using mechanical ascenders requires the most amount of equipment, expertise, and time and is usually appropriate only for longer term studies, when repeated access to one tree is desired. French telephone pole climbing spikes ("griffes") provide the cheapest and lightest method of access, but they are suitable only for trees with a diameter of 49 cm or less. The canopy of larger trees can often be accessed from smaller trees using the extendable tree pruner. Forester spikes are also lightweight and cheap, and they can be used on larger trees, but they do not provide the level of support of griffes. Both types of spikes injure trees and probably increase mortality, so their use may not be acceptable in certain areas or in long-term studies. The Swiss Tree Grippers are usable for diameters from 18 to 72 cm and, unlike spikes and griffes, do not damage the tree. They are, however, considerably heavier and more expensive.

Specimens from trees may also be collected by throwing a line over a small branch and then either pulling until the branch breaks (Hyland, 1972) or sending a wire saw or cutter over the branch to cut it down (Collis & Harris, 1973). A review of techniques used to climb and collect specimens from trees may be found in Wendt, 1986.

First-Aid Kit Collectors should be able to provide first-aid treatment for broken or sprained limbs, insect and snake bites, allergic rashes, cuts, blisters, minor infections, and sunburn.

General Considerations

Choosing the Sample

Most plant individuals will have a range of foliage and inflorescence sizes. The sample chosen for pressing should be representative of the size, variation, and general appearance of the plant or population collected. Even though collection of excessively damaged leaves and plant parts should be avoided, the selection of samples for pressing should not be based on their attractive appearance or convenient size but rather on their representative-

Gathering Sufficient Material

Enough material should be gathered to produce as many duplicates as needed. Usually at least three sets are needed: one set for the collector's institution, one set for the specialist determining the specimen, and one more set for the host country. Additional sets are often required or welcomed by other institutions in the host country and abroad. Thus, most botanists collect from five to eight fertile duplicates for each collection number. Three duplicates of sterile specimens, however, is an adequate amount. Collectors should gather more than enough flowers and fruits; some may become dislodged or damaged, and taxonomists may need to remove and dissect a few. Extra flowers may also be packed in small packages and included with the specimen, as these are often extremely useful for identification. Bulky inflorescences may be trimmed down, and the cuttings can be dried separately and eventually included in a small package. Enough individuals of small plant species should be included to fill a whole sheet, but collectors should ensure that all individuals are from the same population. Also, care should be exercised, particularly when collecting in frequently visited areas, not to deplete the populations of rarer species.

In some cases, flowers are taxonomically more important than fruits, and in some cases the opposite is true. Ideally, both should be collected, so two collections may be required: one during flowering and another during fruiting. For trees, it may be useful to include a strip of bark or a picture of a small slash made on the trunk with a knife. Collections of small plants should include the roots, but care should be taken to remove all soil.

Sterile versus Fertile Specimens

Sterile specimens, without flowers or fruits, are difficult to identify and are taxonomically useless. Their determination is at best unreliable and usually is incomplete. Sterile collections should be made only if the plant is important from an ethnobotanical standpoint and if a fertile specimen cannot be located. Efforts should be directed during the remaining time in the field to collect a fertile specimen. Individual trees can be marked with a plastic ribbon and collected at a later date when they are fertile.

General Procedure

Using a Field Press

As stated previously, specimens should be pressed in the field whenever possible. Before pressing herbaceous plants, shake the roots or wash them to remove any mud or sand. Clumps of grasses and sedges may need to be broken up, in which case the fact that clumps were broken should be indicated in the notes. Specimens should be cut and/or folded to fit neatly inside a folded sheet of newspaper and then slipped between two pieces of felt paper and placed inside the field press.

Whenever possible, the whole plant should be collected. Some herbaceous plants and most woody plants are too large to fit in a newspaper sheet, even when folded. In this case, an appropriate section of the plant must be selected for the press. A plant with intermediate-sized foliage and inflorescence should be selected, together with a separate leaf of the largest size found on the plant. All duplicates should be collected from the same individual, except for individuals too small to fill a herbarium sheet. In this case, collectors can include several individuals of the same population.

Large compound leaves, such as those of palms and ferns, should be measured and the number of pinnae or leaflets counted. Photographs of the whole leaf and plant are also useful. Apical, mid, and basal sections of the appropriate size can then be cut (see Balick, Chapter 5, this volume). If not pressed in the field, loose parts should be tagged and carried in a collecting bag back to the base camp, where they can be dried separately.

Delicate or ephemeral flowers should be placed in small envelopes of folded, preferably waxed, paper with some corollas open to show the internal structures. These envelopes can be placed with the plant specimen or labeled with the same collection number and carried separately in a pocket press or notebook.

Using a Collection Bag

When carrying specimens in a bag for subsequent pressing in the base camp, collectors should cut each sample to a size slightly larger than that of the pressed specimen. Each sample should be labeled with masking tape or a paper tag with its respective col-

easily get mixed up. All samples of the same collection should be carefully bundled and gently but firmly pushed to the bottom of the bag.

Delicate plants or plant parts, as well as loose material, should be placed separately in labeled bags or enclosed in a newspaper sheet and placed in the field press. Large, heavy fruits or samples should not be placed on top of the bag, as they will crush the specimens underneath. Instead, they should be labeled and packed in a separate bag or placed at the bottom of the collecting bag.

To prevent plants from wilting, do not leave specimens in the bag for too long, especially in the heat. The bag should be kept in a cool, shaded spot until the material can be pressed. Transparent plastic bags should be avoided unless placed inside an opaque bag, as the "greenhouse effect" will accelerate wilting of plant specimens. In addition, wet newspapers can be placed inside the bag, or water can be sprinkled over the specimens.

When ready to press, do not pull specimens out of the bag, because they will tear. Instead, hold the bag upside down and carefully shake out its contents while trailing the bag across the floor or tarp. This method should leave a neat row of plant bundles along the floor, each corresponding to a different collection.

Collection Numbers

A standardized numbering system should always be used to label all collections and cross-reference them with the field notes. Every collector should have his or her own collection number series, which usually consists of his or her name followed by a number. Collections should be numbered sequentially, beginning with number 1 and proceeding ad infinitum. Newspaper sheets containing specimens should also be labeled with the collection number: many collectors also include their initials to distinguish them from the numbers of other collectors. Numbering systems that initiate a new number series every field trip or year are *not* recommended because repeated numbers may subsequently be confused and will create difficulties for workers and monographers referring to the collections.

- Any one collection number should be used only once. If two collections are accidentally given the same collection number, they can subsequently be distinguished by using a letter as a suffix (e.g., *a* and *b*). Thus, all duplicates of Martin Smith's first collection will be M. Smith 1 or MS 1. There should never be another Martin Smith collection with the same collection number.
- Except for very small plants, in which case one individual is insufficient to fill one sheet, any one collection number (including all its duplicates) should contain fragments from **only one individual plant**. Other individuals, even if they are of the same species and variety, should be given new collection numbers. Similarly, if the same individual plant is collected at a later date, a different collection number should be used.
- In cases where each set consists of several sheets, as with large-leaved plants, each sheet should be labeled accordingly: for example, sheet 1 of 3, sheet 2 of 3, etc. When a group of collectors are collecting together, only one collection series number should be used for each plant: the same individual plant *should not* be collected using several collectors' numbers.

The Collection Notebook and Field Notes

Field notes are one of the most important, yet most frequently overlooked, aspects of collecting. Good field notes make the herbarium sheet a valuable research tool and are essential for obtaining accurate taxonomic determinations. Notes should be taken when collections are made, since later in the day it is easy to forget or confuse important details of the plant or collecting site. Notes should be written *clearly and legibly*, especially if they are to be transcribed onto labels by others. Abbreviations should generally be avoided, unless these are universally recognized. If abbreviations are used, a key must be provided in the notebook. Some botanists prefer to take notes in the field in a small pocket book, transcribing the final notes neatly onto a larger book at the end of the day. This procedure takes more time, but the choice of method is up to the individual. Collectors *should not* wait to get back to the camp to write field notes from memory. Also, a complete set of photographs or video notes of the

collection notebook should always be kept, in case the notes are lost, stolen, or damaged.

In addition to the collection number, date, and collectors' names, the following information should be included in the collection notebook for each collected plant.

- Latitude and longitude. Can be obtained from a detailed map of the area.
- Altitude above sea level. Can be obtained from large-scale topographic maps or, preferably, read from a calibrated altimeter. Although extreme accuracy is unnecessary, some of the cheaper makes should be avoided, as these may be highly inaccurate and subject to variation.
- Locality. Country, state or region, province.
- Exact location. The description of the exact location should be detailed enough to allow another person to find the site on a map or to return to the site at a later date. The distance and direction from important, well-known topographical or man-made reference points such as a river mouth, mountain top, town, or road should always be indicated.
- Habitat and vegetation. Type of habitat (e.g., riparian, primary forest, secondary forest, cultivated field, etc.) should be described. If possible, a description of the dominant vegetation, as well as of typical or associated species should be provided.
- Topography and soil. Notes should be included on the characteristics of the terrain (e.g., rugged, sloping, flat), as well as on the type of exposure (sunny, shaded) and soil type (e.g., clay, sand, alluvial, volcanic, well-weathered, extent of organic accumulations).
- Taxonomic identification (family, genus, species). Field identifications are only tentative, especially beyond the level of family. A list of field guides to neotropical families is provided in Appendix 1.
- Plant description. This should include information about characteristics of the plant not visible in the dried specimen. Some important characters include:
 - Habit. Whether the plant is a tree, shrub, epiphyte, vine, herb (annual, biennial or perennial), solitary, or colonial.
 - Height of plant. A rough estimate is usually adequate.

Stem or trunk characteristics. The diameter at breast height (dbh) of the stem or trunk of woody plants should be indicated. Any distinguishing characteristics of the bark, including color, texture and thickness, should also be noted. For fleshy stems particularly, collectors should indicate if the cross section is round, flattened, or square.

Architecture. Any characteristic type of branching (erect, pendulous, etc.) and crown shape should be noted.

Flowers and fruits. Color, odor, shape, and size should be indicated. The numbers of stamens and styles on flowers are easier to determine in the field than when the material is dry. Floral formulae are a useful and quick way of recording the number of parts. Fruits should be opened, and the aril and seeds described if present. Information on fruit texture and consistency should also be recorded.

Other. Any other characteristic anatomical or morphological feature that may not be visible in the voucher should be noted, including extremes of morphological variation found in leaves and other organs. The presence, consistency, and color of any **latex**, **resin**, or **sap** should be indicated, noting any differences between trunk and twig exudate. Finally, the presence of any insects associated with the plant, including pollinators and symbionts, should also be recorded.

- Number of duplicates collected. This can be annotated under the collection number, in the left-hand margin of the fieldbook. This information is necessary to print the correct number of labels during processing of collections at a later stage. The number of duplicates left in the host country should be specified for each number, so that labels can be sent there.
- Others. Collectors should also indicate in their field notes whether any photographs have been taken, whether fruits have been dried and stored separately, and whether the vouchers were preserved in ethanol or given any other chemical treatment.
- Local name and uses. See Alexiades, Chapter 3, this volume.

To save space and time, you can note the date, collectors, latitude and longitude, altitude, and location of the collection site.

series of collection numbers, if they are all collected in the same area on the same date and by the same people. A change in collecting date, collectors, or geographical location should mark the beginning of a new section (but not a new series of numbers) in the collection notebook. Some collectors indicate at the start of each series which collection numbers are included for that particular series. Another system is to write the full information for the first collection number (e.g., 509). If the next 10 collections were made in the same locality, "509" can be written next to "Locality" for each. The latter system is generally more cumbersome, especially when typing labels from the notes or when needing to refer to the collection notebook. The beginning of a new series of collections is often indicated by drawing a horizontal line across the page. The increasing availability of portable computers makes electronic data entry an increasingly accessible option.

The Herbarium Label

The herbarium label contains the information recorded in the field collection notebook and is affixed to the herbarium specimen. Although labels can be mechanically typed on any acid-free, archival paper, the most effective way to prepare labels is by using a label-generating program, usually as part of a database or word-processing software. The advent of portable hardware means that labels can be produced in the field, thus speeding up the processing of collections. A typical layout of information and sample herbarium labels are illustrated in Figures 3 and 4.

Pressing and Drying

Plant Specimens

Plants collected in a plastic bag should be pressed as soon as possible. Plants brought from the field press should be transferred to an ordinary press for drying.

The Plant Press

Plant presses are used to dry plant specimens while keeping them

① The New York Botanical Garden
 ② Plants of BOLIVIA
 ④ Morac.
 ③ *Poulsenia armata* (Miq.) Standl.
 det. M. Nee, 1991
 ⑤

Depto. Santa Cruz, Prov. Ichilo, Parque Nacional } ⑥
 Amboró, Río Saguayo near mouth of Quebrada }
 Yapoje. Secondary tropical evergreen forest near } ⑦
 camp around abandoned slash and burn plot.
 17°34'S, 63°44'W. ⑧ Alt. 350 m.
 ⑨ Young tree, 2 m. tall; sap milky.
 ⑩
 ⑪
 ⑫
 Coll.: M. Nee 40910
 11 June 1991

Figure 3. The herbarium label. 1. Institution with which the collector is affiliated. 2. Project title. 3. Genus, species, and author. 4. Family. 5. Specialist and date of determination. 6. Locality. 7. Vegetation and habitat. 8. Latitude, longitude. 9. Altitude. 10. Plant description. 11. Collector(s). 12. Collecting date.

sheet of newspaper, which is in turn sandwiched between two sheets of blotting paper and two pieces of corrugated cardboard or aluminum, each 12 x 18 in. (Figure 5).

After all specimens have been arranged on top of each other and sandwiched between blotters and corrugated sheets, a wooden frame is placed at both extremes of the pile and tied together as tightly as possible with a pair of ropes or webbing straps, 6-10 ft long. The blotting papers gradually absorb the water from the plant tissues, while the pressure on the specimen prevents the specimen from wrinkling. The corrugated sheets facilitate the flow of air through blotters, thereby assisting in the drying of the plant specimen.

Plant press frames may be purchased, cut from plywood, or made from slats (1/4 in. thick, 1 in. wide) of any hard, flexible wood. Five pieces, 18 in. long, and six pieces, 12 in. long, are nailed or screwed together to form a frame. The slats are

ECONOMIC BOTANY OF THE BORA INDIANS: PERU
 No. 1006
Abuta rufescens Aublet
 det. B.A. Kruckhoff 1981

Dept. Loreto, Prov. Maynas: Río Yaguayacu, affluent of Río Ampayacu.
 Brillo Nuevo and vicinity, approx. lat. 2°40', long. 72°00'

Vine 2 meters tall, leaves dark green above, light green beneath. Underside of leaves and stem are hairy. In forest.

Bora: namityahken

Use: to make curare, now little used as shotguns are common.

M. J. Balick, D. R. Allon, J. P. Razon 2/78

Gossypium MALVACEAE

PERU, Dpto. Madre de Dios. Provincia de Tambopata. Río Tambopata. Comunidad Nativa de Inferno. Quebrada de Torén. 12°50'S, 069°17'W. 00260m. Cultivated next to house of don Walter Torén.

Shrub to 2m, branched; flowers yellow, maturing pinkish.

D.V.: Algodón blanco (Spanish).
 USE: Intestinal for skin turgor (unripe fruit). Apply fruit peel scrapings.
 Pharmaceutical (leaves). Drink infusion
 M. N. Alexiades 1006 August 1, 1990

Fieldwork supported by the Edward John Noble Foundation

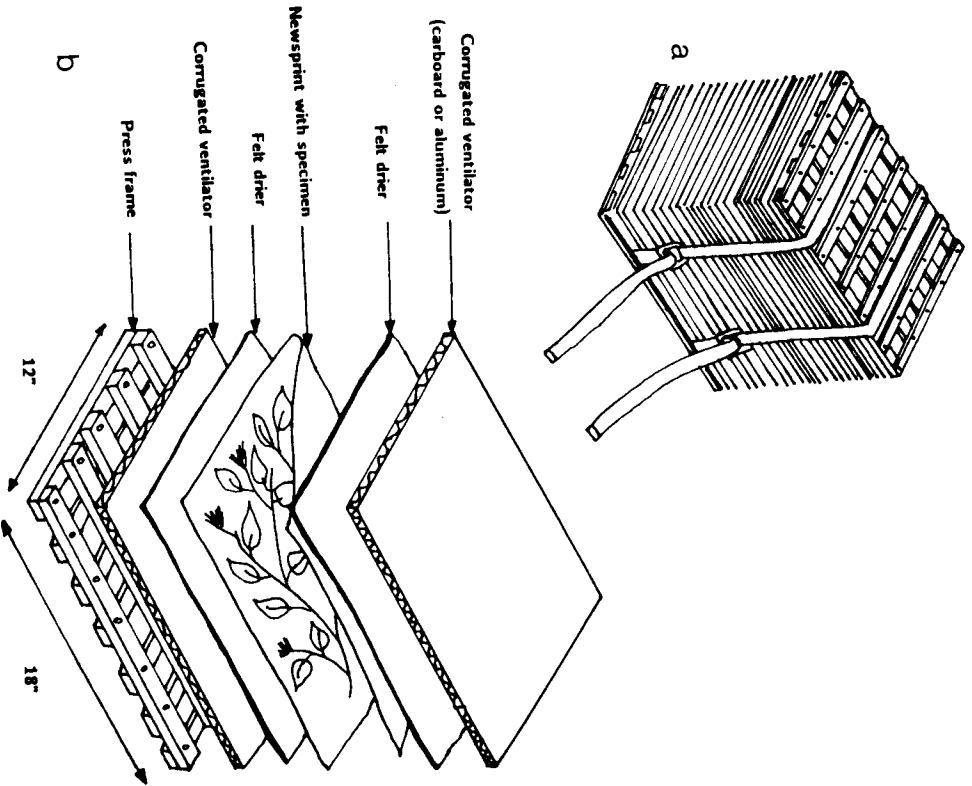


Figure 5. The plant press. **a.** Assembled view. **b.** Exploded view showing components. (Redrawn from Saville, 1962.)

should be placed on the same side of the lattice. Plant presses can also be improvised in the field by placing plants between two boards and applying pressure with a heavy rock.

Blotters and corrugated sheets may be purchased, though it is also possible to use thick pads of newspaper instead of blotters.

that the channels run along the width of the board). Cardboard blotters are cheap and lightweight, but they need to be dried at regular intervals because they absorb moisture from the drying specimens. Also, time and use cause the corrugations to collapse, and the sheets need to be replaced. Aluminum blotters, on the other hand, are very durable but heavy and expensive. Because cardboard corrugated sheets need to be regularly taken out of the press and dried, collectors need to carry more of them than aluminum ones.

While specimens are drying, particularly during the early stages, the press should be regularly checked to ensure that the straps remain pulled tightly enough: as the plant specimens dry and shrink, the press tends to become loose, resulting in wrinkled specimens.

Arranging Specimens for Pressing

Correctly arranging the specimen in the newspaper before drying is very important; dry specimens are brittle, and their parts can not be rearranged without breaking off. When arranging the specimen, collectors should ensure that it is cut to the right length. To do so, place it over the newspaper and cut the excess length from the base (Figure 6). When cutting off leaves or twigs, leave a portion of the base intact to indicate its position. It is also possible to fold the stem (Figure 7).

Both surfaces of the leaves and reproductive structures should be visible, so at least one leaf and one flower should be turned over. If only one leaf fits in the newspaper, it should be folded in such a way that both surfaces are exposed (see Figure 1). Collectors should note that often the lower leaf surface has more diagnostic characters than the upper surface. If necessary, one side of very large symmetrical leaves may be removed.

Some flowers should be pressed open, some closed. If possible, one flower should be dissected to show the internal structures. Extra fertile material for study and dissection should also be included whenever possible. Care should be taken that nodes, flowers, or fruits are not accidentally covered by folded leaves. Large leaves should be folded away from these parts or tucked underneath (Figure 8).



Figure 6. Cutting the specimen to size. (Redrawn from Liesner, 1985.)

surface—especially the apex and base (Figure 9). Leave all the leaves you can; trim only if they lie several deep on the sheet. Do not leave any plant part projecting out of the newspaper; these parts will break off when they are dry. Instead, fold or tuck in neatly any leaves or stems that jut out of the news sheet.

Pressing Large or Fleshy Parts

Sections from large tubers, corms, bulbs, and the like, may be cut, noting the thickness and length of the part. Whenever possible, the outside surface should be included. Bulky adventitious root systems can also be thinned down. Whenever pressing sam-

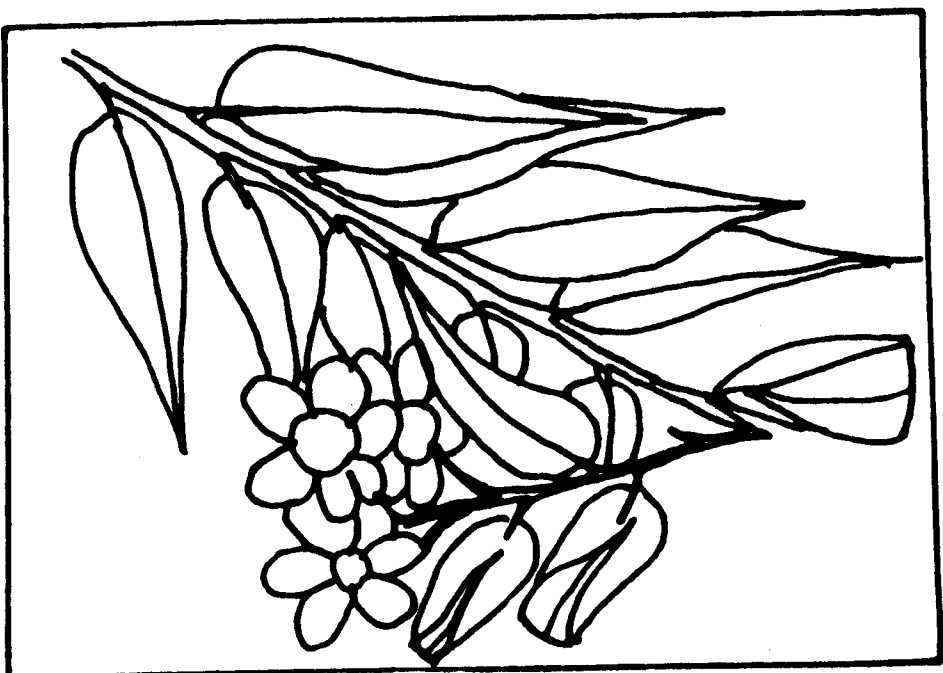


Figure 7. Folding the specimen. (Redrawn from Liesner, 1985.)

to maintain a constant pressure. This padding prevents corrugated sheets from slipping out from the bottom of the press when pressure is applied, and it also keeps specimens from wrinkling.

Cross and longitudinal sections of fruits should be included whenever possible. Fruits can also be cut and dried in a separate sheet and combined with the leaves once dry. Large fruits, par-

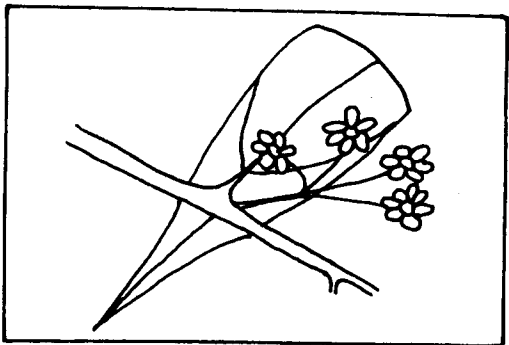
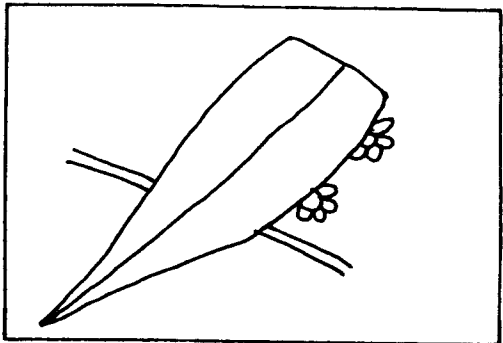
**YES!****NO!**

Figure 8. Correct and incorrect ways of folding leaves. (Redrawn from Liesner, 1985.)

cotton, or (least preferable) paper bags. When fruits are separated from the main collection, the caption "Fruits Separate" should be written in the newspaper folder and in the collection notebook. Large inflorescences can be photographed, measured, and thinned. Many of these thinnings can be pressed separately and packed as extra material for dissection.

Balancing the Press

Usually no more than 60 to 90 specimens, fewer if they include bulky material, should be placed in a single press; larger presses often become unwieldy and difficult to balance. When building a press, keep the numbered side of sheets facing up. The press can be balanced by turning alternate collections around, so that the open ends of the folded newspaper face opposite directions. The press can also be balanced by placing large fruits and stems on

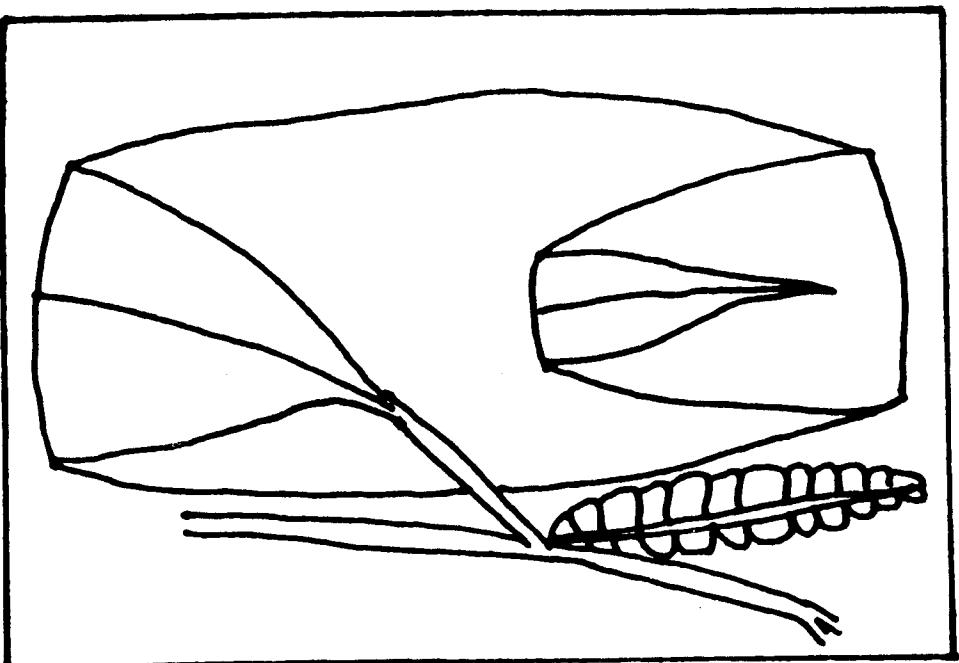


Figure 9. Folding large leaves. (Redrawn from Liesner, 1985.)

Drying Specimens

Plants kept for too long before drying may mold, and the leaves may abscise. It is possible to dry small numbers of specimens by leaving the press in the sun, replacing the moist blotters with dry ones every 8 hours. The moist blotters and corrugated cardboard should be thoroughly dried in the sun and the process repeated

time to change the newspaper sheets in which the plant specimen was pressed, as doing so may damage the specimen and lead to confused numbers or lost plant parts.

An artificial source of heat is usually necessary to dry specimens. Presses can be suspended above stoves or open fires, placed close to chimneys or next to generator exhausts, . . . the possibilities are innumerable. In any case, care should be exercised to ensure that there is enough heat to dry the plants as fast as possible while, at the time, avoiding excessively high temperatures, which could cause a fire or destroy the specimens: the press should never be too hot to touch.

One of the safest, most common ways of drying plants is to build a dryer. A dryer consists of a wooden or aluminum rectangular box measuring 18½ in. across, 23 in. high, any desired length, and a heat source. Two cleats, about 1 in. wide, run along the top side of the box supporting the plant press. A wire screen is often stretched between these cleats to prevent anything from falling down onto the heating elements and starting a fire. A prototype for a portable dryer is shown in Figure 10. A higher

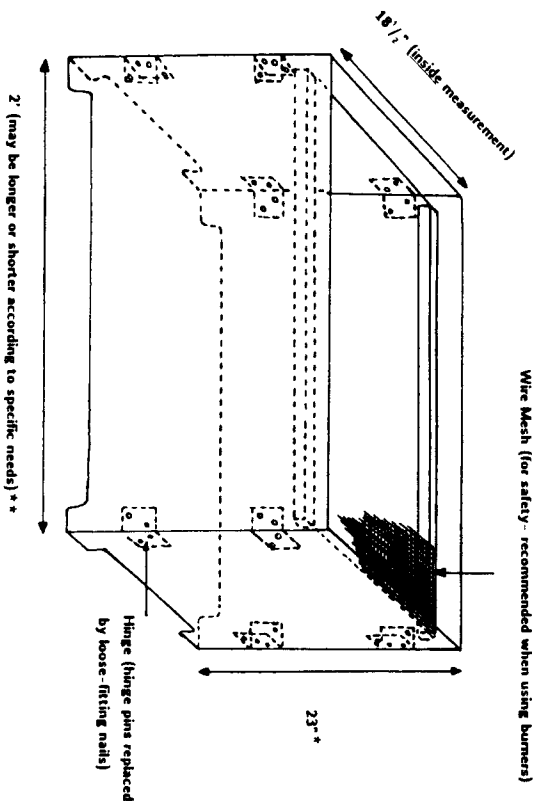


Figure 10. Portable plant dryer. * = A longer section, totally or partially enclosing the plant press, is more efficient but bulkier. ** = This section may be cut into two

box in which the plant press is totally or partially enclosed is more efficient but obviously bulkier and heavier.

When electricity is available, six or more 100- or 200-watt light bulbs can be used as a heat source. Light bulbs are safe, but they need constant replacement and in some areas are expensive. Heat lamps, resistance coils, or heating strips may also be used. In the absence of electricity, bottled gas provides a good source of energy. Portable kerosene stoves sold all over Latin America are very basic, cheap, and effective. Any naked flame should be covered with a metal plate in order to minimize the risk of fire and to diffuse the heat. When drying specimens, use a lid to cover parts along the top length of the dryer that are not covered by the plant press; this arrangement will force hot air through the press corrugates.

Excessive drying of specimens will "cook" them and make them very brittle. To check if specimens are dry, feel the fleshier parts, such as stems and fruits, as these take the longest to dry. One way of checking is to press gently with a fingernail until a slight crackle is heard or felt. If any parts feel cool, soft, or damp, the specimen is not dry. Drying time will vary according to the amount of heat applied and the amount of water in the plant tissues; times vary from 8 hours to several days.

Preserving Plants before Drying

In some cases, it is not possible to press and dry plants in the field. One possibility is to soak bundles of plant specimens with alcohol inside heavy-duty plastic fertilizer bags until they can be dried. Specimens can be stored in good-quality plastic bags with 70% or higher alcohol solution for several weeks. Although more-dilute solutions can be used for shorter-term storage, solutions of less than 40% should be avoided. Some botanists add formaldehyde to this solution, particularly as this seems to subsequently offer some protection to dried specimens against insect attack. But formaldehyde makes subsequent handling of specimens unpleasant and potentially hazardous owing to toxic fumes.

Specimens to be kept in a preserving solution should be packed into package bundles 9 in. thick, wrapped in newspaper sheets, and packed snugly into the plastic bag. The alcohol, 1-2

use of any preserving solution should be clearly indicated in the collection book and on the specimen labels, since some of the properties of the specimens, including color and chemistry, may be altered by the procedure. *Note: When preserving specimens in alcohol, test the pen to ensure that its markings on the newspaper sheets will not be erased.* Wax crayons are a good writing instrument when specimens are to be preserved in alcohol.

Packing and Shipping Specimens

Dry specimens should be arranged into 9–12 in. bundles, placed between two cardboard sheets, and securely tied with heavy twine. For additional protection, each bundle can be wrapped in heavy paper or plastic. Naphthalene may be added to prevent insect damage. The bundles should be stored in a dry place. Under humid conditions, it may be necessary to pack bundles in tightly sealed fertilizer bags. When shipping specimens, snugly pack bundles in strong wood or corrugated cardboard boxes. The latter may not be suitable if the boxes are to be exposed to rain or humid conditions. Collectors should arrange the necessary export and import permits before shipping any specimens. Often, clearance from CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) must be obtained, as well as a phytosanitary permit, certifying that specimens do not include endangered species and are not contaminated with mold or insect pests.

Acknowledgments

Camilo Díaz introduced me to the science and art of collecting plants. Bradley Bennett, Scott Mori, Michael Nee, Christine Padoch, Daniela Peluso, Charles Peters, Oliver Phillips, and Jennie Wood Sheldon provided many helpful comments on earlier drafts of this paper. I am also grateful to Michael Balick and Jan Stevenson for their helpful suggestions and support in writing these guidelines. The Institute of Economic Botany of The New York Botanical Garden and the National Cancer Institute supported the preparation of this paper.

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5

Collecting Palm Specimens

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Introduction
Collection Techniques and Methods
Conclusion
Acknowledgments
Literature Cited

Introduction

Palms are distributed throughout much of the tropics, including the Neotropics. Economically and ethnobotanically, palms are one of the most important plant groups of the tropical forest (Balick & Beck, 1990). In some areas, they are scattered throughout the vegetation; in others, palms are the dominant forest trees. In fact, oligarchic stands of palms are quite common, especially in habitats that are not well tolerated by most dicotyledonous species, such as swamps and areas subject to seasonal inundation

tance as a part of the overall tropical rainforest biota (Kahn & Granville, 1992), as well as their many economic and subsistence uses (Balick, 1988), palms are usually poorly represented in the study collections used by biologists. One study (Balick et al., 1982) documented the lack of good palm collections from one important region: only 37.5% of the 232 recognized palm species in Brazilian Amazonia were present in any of the three local herbaria within that zone. Of the species present, many lacked crucial information on their labels, and others were badly preserved. Although a surge of interest in and field studies of the palms have increased the numbers of specimens in local and international herbaria since that study, the group is still underrepresented. As a result, local studies of ethnobotany, ecology, population biology, and floristics are hindered by not having adequate and complete reference collections with which to compare material being brought in from the field.

It is important to emphasize that good collections of these plants are necessary in order to make positive identification possible. A poor palm collection is worse than no collection at all in that it tends to give a misleading impression of the plant or creates many unanswerable questions. Because palms are often rather large, or contain organs that are hard to press, collecting them often requires a considerable effort.

Collection Techniques and Methods

Here I summarize some of the techniques and methods for making a good palm collection. This information is presented in greater detail in Balick et al., 1982, and the interested reader is also directed to Fosberg & Sachet, 1965, for additional information on this topic.

Because of the rather large size of many palm parts, it is difficult to collect entire organs such as leaves, which may be up to 8 m long and may weigh 20 kg or more when fresh. Similarly, a fruiting panicle with 30 kg of coconut-like fruits would be extremely difficult to collect, dry, ship, and curate in its entirety. Therefore, it is advisable to make collections with representative parts of each of the major organs. Through the use of photographs and very detailed measurements, one can subsequently re-

palm. Good palm collections should include the following 10 elements:

1. *Leaf apex in pinnate-leaved palms; leaf hastula in palmate- or costapalmate-leaved palms.* The apical pinnae can be fused in a distinctive way or have dimensions altogether different from the middle pinnae. The hastula, or ligula, as it is sometimes known, often varies in shape and size and can provide some element of distinction at the species level.
2. *Leaf pinnae and at least a portion of the rachis in pinnate-leaved palms; leaf segments in palmate-leaved palms.* The pinnae are often crucial for making generic and specific determinations.
3. *Flowers, fruits, or both.* Flowers and, to a lesser degree, fruits usually contain the most essential criteria for systematic identification of palms, at both the generic and specific levels. It is essential that collections include such fertile material. It is often possible to locate an individual plant in flower while at the same time locating a similar individual of the same species having fruit in some degree of maturation. While it is preferable to obtain flowering and fruiting material from the same tree, it is also permissible to collect flowering and fruiting material from different individuals, if great caution is taken to collect from the same species. The herbarium label should note that sexual material was taken from different trees.
4. *Flowering or fruiting axes or both.* The morphology of the flowering or fruiting axes often provides important criteria for taxonomic identification. Smaller axes should be collected in their entirety; larger ones should be photographed and measured carefully.
5. *Supplementary material: bracts, sheaths, spines, wood samples, stems, and seedlings.* Such materials may be helpful in identification, depending on the taxon in question.
6. *Quantitative and qualitative information on vegetative, reproductive, and morphological characters not apparent on the specimen.* It is essential to spend as much time as needed to properly document the presence, distribution, and dimensions of vegetative, reproductive, and morphological char-

bits of information that cannot be fully and accurately preserved or discerned. For example, some palm fruits change color when dry. Another example would be the dimensions of a large leaf, which might be represented in the herbarium collection by only a sample of the apical, middle, and basal pinnae and rachis. It is very important that proper measurements be made in the field and faithfully transcribed on the herbarium label.

7. *Information on habitat.* These data should include comments on altitude, substrate, vegetation type, and degree of habitat disturbance. Because many species of palm are limited to specific habitats, such ecological indicators may be especially useful in identifying a species.

8. *Reasonably precise locale.* As is the case in all herbarium collections, information on locale is essential, especially if the specimen represents a newly discovered, rare, or endemic species.

9. *Vernacular names and uses.* Most palm species are referred to by vernacular names, and many have local uses. Vernacular names are extremely helpful in relocating species populations in the field, and ethnobotanical uses may be indicative of species of potential economic value worth developing further. It is surprising how many palm collections are lacking such information (see also Alexiades, Chapter 3, this volume).

10. *Good-quality black-and-white or color photographs.* Even if they are not contained in the herbarium collection, it is extremely important that the collector take adequate pictures of the palm before and after it is collected. Especially helpful, for example, are habitat photographs, a shot of the individual specimen(s) collected for harvest, and close-ups of the reproductive parts, leaf, stem, and other subsidiary organs. These photographs are often kept by the collector, and their availability is indicated on the label. Although useful, it is admittedly rather expensive to include original photographs in each herbarium collection.

Because the proper collection of a palm often results in sacrifice of the tree, it is important to make as many specimens as possible from that particular individual. In general, I find that six specimens are sufficient—from one to three deposited in the

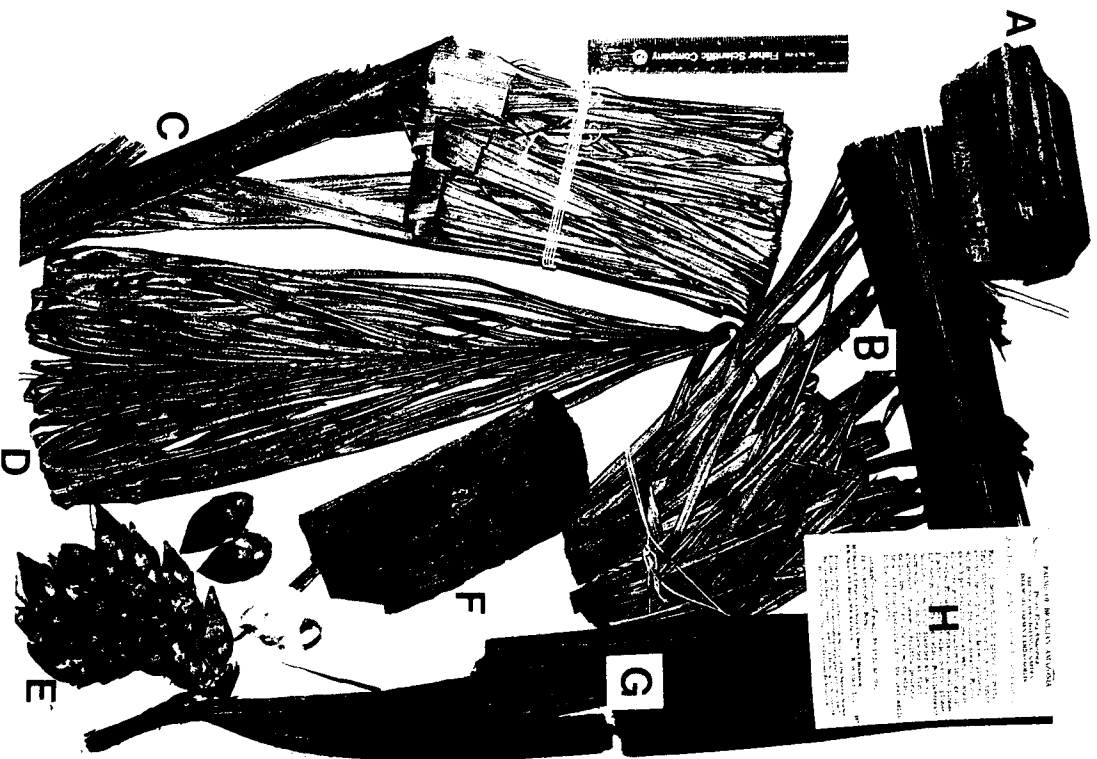


Figure 1. Example of a complete herbarium collection. Specimen of *Attalea maripa* (Aubl.) Mart., collected along the Santarém-Cuiabá Road, BR 163, Km 890 from Santarém, Pará, 10 Nov 1977, M. J. Balick et al. 920. Portions represented are: **A.** Section of Petiole. **B.** Lowermost section of leaf rachis with basal pinnae. **C.** Midsection of leaf rachis with folded pinnae (note that pinnae on left side of rachis are removed and only their bases remain to indicate position of insertion into the rachis). **D.** Apex of leaf. **E.** Section of fruiting panicle, several rachillae and sample of fruit. **F.** Stem section. **G.** Inflorescence bracts, sliced along their length. **H.** Herbarium label. (Originally published in *Brittonia* 34: 470, 1982.)

country of origin as requested and three duplicates sent to the home herbarium. More duplicates can be made, although drying these in the field is somewhat difficult, especially if more than one or two good collections are made each day and the collecting activity lasts for several weeks or more. It is not uncommon for palm collectors to find that this material has filled up the field dryers and takes many days to process, resulting in a potential backlog of both palm and nonpalm collections. Figure 1 illustrates a complete herbarium collection of the palm *Attalea maripa* (Aubl.) Mart. from Brazil.

Conclusion

While seemingly difficult, palm collection becomes an interesting and rewarding endeavor once the hurdle of the first few collections has been passed. The collector should be armed with a good ax, machete, clippers, measuring tape, 35-mm camera, and copious supplies of color slide and black-and-white print film. Strong cord and woven plastic sacks are important for carrying the collected material back to the location where it is to be pressed and otherwise processed. The fact that these plants have been somewhat ignored by collectors in the past gives an opportunity to provide great treasures in the form of new hybrids and species, country records, uses, distribution, and other information for today's generation of tropical botanists.

Acknowledgment

This is a modified version of Balick, 1989.

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6

Recommendations for Collecting Mushrooms

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- Introduction
- Collecting Specimens
- Preparing Specimens
- Making Spore Prints
- Making Notes
- Pileus (Cap)
- Hymenophore
- Stipe
- Universal Veil
- Partial Veil
- Drying Specimens
- General Reminders
- Literature Cited

Introduction

Mushrooms, fleshy fungi, are an important ethnobotanical resource. They are used in a variety of ways, including as food, medicine, and in religious rituals. This book provides a comprehensive guide to the collection, preparation, and use of mushrooms.

1979; Findlay, 1982; Wasson, 1975), particularly as sources of food (Beuchat, 1987; Parent & Theon, 1978; Prance, 1984) and in magical or religious contexts (Heim & Wasson, 1959, 1965; Riedinger, 1990; Wasson, 1969, 1980). Although the techniques employed for collecting mushrooms are not complex, they differ considerably from those used to collect vascular plants. Pressing mushrooms will destroy their value as scientific specimens and often will render their taxonomic determination impossible. The following is a summary of techniques for gathering, documenting, and preserving mushroom specimens. Although these may seem at times idiosyncratic and tedious, they are essential for providing useful specimens for later study.

Collecting Specimens

Adequate notes are essential to make complete and valuable specimens. When collecting a mushroom, take note of its habitat and substrate. Common substrates for mushrooms include wood, soil, and leaf litter. If a mushroom is growing on wood, note whether the wood is dead or living. If the wood is living, is the mushroom growing on the bark, or is the wood decorticate? The habitat description should include the kind of trees growing in the area, as many agarics will associate with particular types of tree roots, or they may be substrate-dependent.

When collecting the specimen in soil, be sure to dig down deep enough to remove the whole agaric. Otherwise, remove part of the substrate with the specimen still attached. Try to collect young as well as mature specimens; several stages of development may be necessary for identification purposes. Furthermore, as many individuals as possible of one "taxon" should be collected.

Once collected, the mushroom must be handled carefully. Specimens should be wrapped in waxed paper (never in plastic!) in such a way that moisture cannot escape. A sheet of paper is torn so that a collection can be rolled up inside with the ends twisted closed. Waxed sandwich bags are also useful if available. The wrapped mushroom can then be placed in a sturdy basket or box, again never in a plastic bag, and carried to the laboratory. Never pile mushrooms so high on top of one another that delicate structures are broken. Small tin boxes or rigid plastic boxes can be useful for protecting fragile specimens.

Preparing Specimens

You should begin working on your collections as soon as possible after arriving from the field. Many agarics shrivel or fade within a few hours of collection, even when wrapped in waxed paper. Prevention of overheating and waterlogging during transport to the lab will aid in maintaining the specimens in as fresh a state as possible. It is best if collecting can be done in the morning with the remaining daylight or afternoon allocated to work on collections. You can expect to spend about 15–30 minutes per collection preparing spore prints and notes; a bit more time is required if photographs are taken.

Making Spore Prints

The first thing to do is to prepare spore prints. As the name indicates, spore prints are pieces of paper covered with agaric spore deposits. These are invaluable for identifying many specimens. To make a spore print, first remove the stipe, if present, and place the gill or pore surface down on a white (*never* black or colored) piece of paper. Cover the whole mushroom with some type of enclosed or moisture-resistant container (a drinking glass or jar or plastic sandwich bag; even wrapped in waxed paper can be sufficient). If there are only one or two specimens, it is better to cut a hole in the paper for the stipe rather than removing the stipe.

After one to several hours (sometimes overnight), a white or colored spore print should result (old or immature mushrooms may not give a spore print). Note the color of the fresh spore print, then fold and dry it with the specimen. In many cases, where return to the laboratory necessitates travel from one extreme elevation to another, it is better to attempt the spore deposits in the field. In my experience, agarics collected at high elevations and returned to low elevations will not sporulate. In these instances, however, one can facilitate spore deposits by placing the enclosed preparations in the bottom of the basket or box, even while still collecting, with an attendant note explaining to which collection the preparation belongs.

Making Notes

While the spore prints are being prepared, you can begin to take notes on your collections. Describing the fresh characteristics of agarics is of paramount importance to preparing a valuable specimen because many important and diagnostic features will disappear when the specimens are dry. Most importantly, color, shape, and size will change, and the odor or taste, if present, will no longer be evident. Notes on the fresh appearance should include any descriptive information that will not be evident after drying.

Essentially, agaric sporocarps can be divided into three parts: the **pileus**, or **cap**, including the interior flesh, the **hymenophore** (lamellae, or tubes or pores), and the **stipe** (including the interior flesh). Other features may, or may not, be present. These might include a **universal veil** and a **partial veil**; both are discussed in more detail below.

Pileus (Cap)

- Size range or diameter
- Shape, viewed and described as if sectioned longitudinally. Caps can be convex, concave, bell-shaped, mammillate, etc.
- Color. Center versus margin; surface ornamentation versus background; does color change with age or when the cap is bruised and handled?
- Texture and ornamentation. Is it hairy, smooth, scaly, fibrous, fragile, membranous? Is it slimy, dry, moist, sticky? Is the margin (outer edge) different from the center? What is the overall thickness?
- Odor and taste. *Never swallow a mushroom*. Masticate briefly, spit out, and note whether distinctive or not.

Hymenophore

- Type. Lamellae, or tubes or pores
- Color. Note changes between young and old or caused by injuries and bruises. If injured, is a juice or latex exuded? Is it colored? To what color does it change? Does it change slowly or rapidly? Does it stain surrounding tissues some

- Attachment to stipe (when viewed in a longitudinal section from pileus down through stipe). Can be free, adnexed, adnate, decurrent. Ranges or intermediates may exist; use ranges not absolutes.
- Edge. Note color, any differences between the edge and the sides, and whether the edge is smooth or serrate.

Stipe

- Size. Include range of length and width.
- Shape: Can be equal, clavate, bulbous, tapering downward, etc.
- Attachment to pileus (e.g., central, eccentric, lateral, absent)
- Color when young and old, above and below, when handled or bruised
- Texture and ornamentation. Same as for pileus. Note basal mycelium and its color, abundance, etc.

Universal Veil

The universal veil is formed of tissue that completely surrounds the immature button stage of an agaric. It ruptures with stipe elongation and may leave remnants on the pileus surface or margin and on the stipe base or surface. It may be persistent or ephemeral. Remnants may appear as warts on the pileus and warts or concentric rings around the stipe base and on the stipe surface, or they may be flaplike patches on the pileus and a cup-like structure around the stipe base. As with other features, note colors and color changes.

Partial Veil

The partial veil is formed of tissue that extends from the pileus margin to the stipe and thus covers the hymenophore before maturity. It ruptures to form a ring around the stipe or a fringe of tissue at the pileus margin; intermediates may occur. Note its persistence, location, whether it is attached or movable. Again, note color and color changes, surface ornamentation, etc.

Drying Specimens

When you have finished your spore prints and have taken notes and observations, the specimens can be dried. This is a very critical

cal step and can make the difference between a valuable scientific specimen and a useless one. Dryers used for vascular plant specimens are usually too hot for drying mushrooms.

Methods for drying mushrooms vary from collector to collector and place to place. The feature they all have in common is that they utilize some kind of fine screen shelving, for suspending the mushrooms over a dry heat source. The heat source can be an electric heater, a tent heater, hot plate, light bulbs, kerosene lantern or stove, and so on. In any case, heat should be directed from the source upward, via a chimney effect, circulating around the specimens and escaping above. Also, it is critical that the specimens be dried slowly (not cooked) in a temperature of 55°–65°C. Specimens confined in an ovenlike space will bake and be useless. Specimens must remain on the dryer at the above temperature until they are crisp and brittle (but not baked or burned). *Never, never place mushroom specimens between newspaper sheets or in a plant press.*

Once dry, specimens must be kept dry or they will rehydrate and then become moldy and worthless. Removing freshly dried specimens directly from the dryer and putting them in a plastic bag large enough to accommodate them will help ensure that the specimens remain dry. In extremely humid regions, a small amount of desiccant can be added to safeguard against rehydration and mold growth. Delicate and fragile specimens can be dried in closed containers containing activated silica gel or other desiccant.

General Reminders

- Collect as many individuals as possible, including a range from young (immature) to old (mature or overmature). Four to five individuals will make an excellent unicate.
- Collect part of the substrate (leaf litter, wood, etc.) and note any phanerogamic association. Plucking while holding onto the stipe can destroy characters or leave part of the fungus behind.
- In preparing descriptions of macroscopic features, describe what you see on the basis of your experience. If in doubt, a sketch is extremely helpful. If at all possible, cut two or

carps are very fleshy, this should be done for all collected in order to promote drying.

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7

Guidelines for Collecting Bryophytes

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- Introduction
- Collecting Techniques
- Preparing Specimens
- Drying and Packing Specimens
- Acknowledgments
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Introduction

Even though bryophytes are not a particularly important plant group from an ethnobotanical viewpoint, they are used in some areas as medicinals (Schultes & Raffauf, 1990), particularly in temperate regions (Johnston, 1987; Turner et al., 1983). Bryophytes are often perceived as taxonomically difficult, but most can be named with relative certainty. Furthermore, unlike higher plants, most bryophytes can be identified in their sterile con-

Collecting Techniques

Bryophytes are among the easiest plants to collect. Only with extreme abuse do specimens lose their value. Although different workers have different field techniques, they are usually just variations on a theme. Because bryophytes have many growth forms, the specific collection procedure will depend on the plant at hand.

Use of a hand lens is essential for critical collecting of bryophytes. As in vascular plants, one can expect variation in the overall aspect of a bryophyte species, and this variation can appear to represent another taxon. Use of a hand lens will, in most cases, resolve any question, because leaf shape and other features of a size easily seen with a hand lens often remain constant. Also, some bryophytes are so small that to even be sure one has a bryophyte, a hand lens is necessary. If there is any doubt about whether one is collecting the same species repeatedly or collecting another, perhaps closely related, species, it is best to go ahead and make the collection.

Loose plants in tufts or mats can simply be picked up by hand, as can pendent forms. At times, however, plants are small or adhere tightly to the substrate. In such circumstances it is best to collect a small amount of the substrate with the plant to keep the plant from being lost or from breaking into many fragments. A knife or wood chisel is the best implement. Soil often stays around colonies of small, terrestrial plants. Indeed, it may be the plants that bind the soil, so soil should not be broken up, although some soil may be scraped from the bottom of the clod.

Small corticolous species are best collected with a shallow strip of bark so that slender stolons or stems that may be present will not be broken or lost. Clippers may be used to collect branch or twig sections with small bryophytes on them. As a general rule, for average-sized bryophytes, a piece the size of the palm of a hand is a good size for a single herbarium specimen. Additional material should be collected, when available, for sending to specialists, depositing in host country herbaria, and other functions (e.g., chemical or molecular analysis). There are small species, though, which, even when common, do not make large patches. Some bryophytes occur only as scattered plants and should not be ignored just because of scanty but well-developed material

General collectors should be careful when dividing material to send to specialists; bryophyte species, like those of higher plants, have distinctive aspects, but at times these may be too subtle for the untrained eye to discern.

Preparing Specimens

Bryophytes are best collected in individual paper bags, with a single collection in each bag. Although some collectors place large numbers of species into a single bag, individual species are often detected more easily in nature, and separation in the laboratory can be dirty and tedious. Plastic bags should never be used unless one intends to examine the specimens within a few days. Bryophytes, especially hepatics, are susceptible to becoming moldy if not allowed to dry or have air circulation. Also some mosses will continue to grow, but in a very odd, etiolated fashion, if left in plastic bags. In general, we have found that 2-lb, flat-bottomed, brown paper bags are the most convenient type. They are inexpensive and come bound in groups of 500 thus allowing easy transport and dispensability. One should purchase these before going to the tropics, since they are often either not available there or are of poor quality (e.g., with V-bottoms and glue that does not hold the bag together under tropical humidity). If paper bags are not available, packets can be folded from any available paper, or bryophytes can be put in a press with higher plants.

Although pressing does not alter critical morphological features, it does give the plant, especially mosses, a less-than-natural aspect when dry. In the case of leafy hepatics, the ideal method of preparation is to remove excess soil and other debris from the still moist (or rewetted) colony and place the plants between papers (or in a folded packet) in a plant press for about 24 hours (without heat). Tension on the press should be light.

Individual bags can also be used to record any desired field data. Although ecologists may be interested in complex habitat parameters, bryologists most often need only basic habitat information. Substrate is often recorded (e.g., tree trunk, moist soil, submerged on rock in stream), as is general habitat type (e.g., tropical rain forest, páramo, thorn scrub). Otherwise, label data should be as for other plants: locality (including latitude and lon-

gritude when possible), elevation, date, and collector (see Alexiades, Chapter 4, this volume). There is no need to give a descriptive account of the plant, as one often does for higher plants, since the whole plant is in the collection and almost never is altered on drying.

Drying and Packing Specimens

Although in very humid habitats it can be helpful to use a plant dryer, in most cases the bags can be left to air-dry. If in a vehicle, the paper bags can be put in a net or burlap bag and tied to the top of the car so that air is forced over them, facilitating drying. Very wet mosses, such as *Sphagnum*, or aquatic species, should be squeezed out, not wrung, to remove excess water. For both mosses and hepatics, air-drying is preferred, but limited exposure to heat in a mechanical dryer does not seriously diminish the value of the specimen.

In general, bryophytes are not excessively brittle, and dried plants do not need special care. An added advantage of individual paper bags is that they act as packing and insulation for the specimens in shipping. Usually just rolling up the bags and putting them in cardboard boxes is adequate protection. Some hepatics and *Sphagnum* (and a few other mosses) can be quite brittle on drying, so specimens should not be packed too tightly in the box, but they should be packed tightly enough to prevent shifting during shipping.

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Collecting Bulk Specimens: Methods and Environmental Precautions

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- Logistics of Bulk Sample Collection
- Obtaining Permits
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- Recording Observations
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