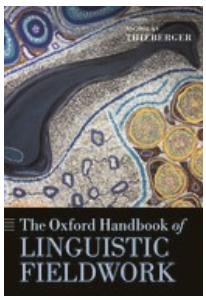

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CHAPTER

11 Botanical Collecting

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Abstract

This article illustrates the requirement of plants and their association with people. Since plants are a very important part of the material and cultural heritage of all communities, those who are interested in studying the culture of a people require an understanding of the plants associated with them. To understand plants and their association with the people, it is important to know the identity of the plant species used by them. Knowing the vernacular name of a plant used by a community assists with communication within that community but fails to provide information to a broader group. Furthermore, the information on how this plant is used by other communities remains inaccessible to most researchers. Therefore, it is important to link local plants to their scientific names so that all the information about these plants is available to everyone. However, the identification of plants is often quite difficult and requires careful examination of the features of the plant and comparison with other previously identified species. Therefore, carefully prepared botanical collections are always required to identify plants with certainty. The study provides a brief introduction to the techniques used for collecting botanical specimens that will enable fieldworkers to provide specimens of plants that are adequate for identification and valuable for scientific study.

Keywords: botanical collection, plant identification, scientific names, vernacular name, plant species

Subject: Linguistic Anthropology, Semantics, Linguistics

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11.1 Introduction[1]

Since plants are a very important part of the material and cultural heritage of all communities, those who are interested in studying the culture of a people require an understanding of the plants associated with them (Fosberg 1960). To understand plants and their association with the people, it is important to know the identity of the plant species used by them. Knowing the vernacular name of a plant used by a community assists with communication within that community but fails to provide information to a broader group. Furthermore, the information on how this plant is used by other communities remains inaccessible to most researchers. Therefore, it is important to link local plants to their scientific names so that all the information about these plants is available to everyone (Conn 1994). However, the identification of plants is often quite difficult and requires careful examination of the features of the plant and comparison with other previously identified species. Therefore, carefully prepared botanical collections are always required to identify plants ↳ with certainty. Furthermore, our scientific understanding of the relationship between plants is constantly being revised, particularly as new techniques and data, such as molecular data, are becoming available; the names of many species have been changed to reflect these changes. Therefore, the lodging of botanical collections in scientific herbaria and museums is important for acquiring the currently correct scientific name for a plant. Since each collection will be available for further study at a later stage, the scientific name can be corrected based on modern knowledge, thus ensuring that vernacular names always remained linked to the correct scientific literature.

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This chapter provides a brief introduction to the techniques used for collecting botanical specimens that will enable fieldworkers to provide specimens of plants that are adequate for identification and valuable for scientific study.

11.1.1 Botanical identification

Many different types of publications provide information about the diversity of the flora of a region. These publications include:

1. Checklists: a simple list of plants of a specific area. Sometimes these lists are annotated with brief descriptive notes, such as Charters (2003–) and Press, Shrestha, and Sutton (2000–). Local authorities, especially environmental agencies, frequently have unpublished checklists that are often more current than the published lists. These checklists can also be very useful for identifying plants from a specific area. However, a high level of botanical taxonomic knowledge is usually required to use these lists effectively to assist in identification.

2. Field guides: usually provide readily observable features that can be used in the field for distinguishing plants of a specific area, usually with brief descriptions, often with illustrations, of the most common plants of an area (e.g. Balgooy 1997; 1998; 2001; Court 2000). Sometimes field guides are only a list of botanical names and photographs and/or illustrations. However, many popular field guides are excellent (e.g. Harden, McDonald, and Williams 2006; Hutton 2008; Steenis 1949–) and these publications are usually adequate for identifying the plants of a specific region.

3. Floras: descriptions, identification tools (keys), illustrations, and images of plants of a specific area, for example Nee (2004, 2008), Stannard (1995), Steenis (1949–). Recently, more of these floras are readily available via the internet, such as Conn and Damas (2006–), Conn et al. (2004–), Flora of Guianas (1885–), Flora of North America (1993–), Hoch (2000–), Western Australian Herbarium (1998–). eFloras (2009) is an excellent on-line resource that provides a comprehensive listing of electronic floras (e.g. Flora of China 1994; Ulloa Ulloa and Jørgensen 2004) and checklists, as well as other information.

4. Scientific revisions: these are more technical scientific publications than the previous examples and
p. 252 are published in peer-reviewed scientific journals and ↳ books. These publications often deal with larger taxonomic groups, such as a family or genus, frequently dealing with a specific geographic area. They provide the same information as a 'Flora' but usually in more detail and with more precise technical terminology than used in the other forms of publications. However, early scientific publications are often very brief, being little more than a listing with a brief descriptive diagnosis in Latin. All forms of scientific revisions usually require a specialized level of knowledge to use effectively.

There are too many useful publications available to provide a generalized simple list here. However, Frodin (2001) provides an extensive and yet selective annotated bibliography of the principal floras and related works of inventory for vascular plants. The book lists principally specialist publications such as floras, checklists, distribution atlases, systematic iconographies, and enumerations or catalogues. A few popularly oriented books are included. Increasingly, publications that are useful for botanical identification and general information about botanical diversity are becoming available in electronic format, e.g. 'Flora of Australia' (ABRS 1981–), 'Flora of China' (Flora of China 1994–) and 'Flora of Taiwan' (TAI 2003–). Other publications are also available electronically, e.g. the printed version of 'Flora Europaea' (Tutin et al. 1964; 1968; 1972; 1976; 1980; Moore 1993) has been replaced by Walters and Webb (2001). Interactive guides to many plant groups have been specifically developed as CD ROM products (e.g. Agoo et al. 2003; Brooker 2006; Hyland et al. 2003; Jones et al. 2006; Maslin 2001; Schuiteman and Vogel 2001; 2002; 2005; 2006; 2008; Schuiteman et al. 2008; Thiele and Adams 2002).

Since new electronic interactive identification tools are being rapidly developed, regular searching of the internet is strongly encouraged. Specific websites (e.g. Anonymous 2001–) provide current information on their theme. The websites of herbaria are also an excellent resource for links to relevant identification publications (e.g. Missouri Botanic Gardens 2009). Of course, the primary resource should always be the authoritative advice of herbarium staff.

11.1.2 Botanical terminology

The descriptive terminology for plants and their component parts have been developed for the purpose of providing an accurate and complete vocabulary for description, identification, and classification (Radford et al. 1998). The collector requires some knowledge of this terminology so that adequate material and accompanying field notes are provided to assist the identification process and to provide material that is useful for other scientific purposes. For example, a basic understanding of the structure of flower is required if the colour or shape of the parts of a fresh flower are to be described unambiguously for interpretation of the dried material. A glossary of technical terms is usually provided in regional 'Floras' (Conn and Damas
p. 253 2006–) and in specialized textbooks on plant systematics of taxonomy (Radford et al. 1998–). ↳ A generalized search of the internet will recover several excellent on-line glossaries of botanical terms (e.g. Lyne n.d.; Flora of China n.d.; Wilmé 2002–). However, it is preferable to use the glossary of terms provided in the publication being used for identification purposes. Some otherwise 'standard' terms may be defined slightly differently in various botanical publications. The terminology used in this chapter has been simplified as much as possible, but reference to a botanical glossary may be required. There are a few specialized glossaries that assist with the translation of a botanical term to other languages (e.g. Rossi-Wilcox n.d.).

11.1.3 Collecting equipment

Botanical collecting, especially in remote areas, requires considerable planning before the fieldwork is undertaken. A summary of what should be done to ensure safe and successful field studies is discussed in §11.6. Before starting to collect botanical specimens, the correct equipment is required. The equipment includes: secateurs, hand lens (10× magnification), jeweler's tags, field book, knife, paper and plastic bags (of various sizes to put plant samples in), small clip-lock plastic bags, silica gel (for drying samples quickly if required for molecular studies), plant press, newspaper, cardboard sheets, tissue paper, GPS (Global Positioning System), maps—topographical, road, and any other maps of the area—pencil (preferable) or waterproof or permanent-ink pen.

11.1.4 Using local knowledge

Local knowledge of the landscape (see Turk et al., Chapter 16 below), other natural features including local climate, and an understanding of modifications to the local environment are always valuable. This information may mean the difference between finding a plant and not locating it. Furthermore, since you may need to visit or traverse private land, it is important to obtain permission and assistance from local landowners before undertaking any field activities.

11.2 The Botanical Collection

The essential aspects of making an adequate plant collection for identification and further scientific study include collecting botanical material that is of adequate size and has required morphological features, and the provision of adequate supplementary information provided by the collector.

p. 254 The importance of collecting adequate botanical specimens cannot be overemphasized. Good specimens are always required for accurate identification. The morphological characteristics of good specimens form the basis of continuing scientific research. Although other sources of data are being increasingly utilized, such as molecular data, morphological features remain the primary source of data for communicating species concepts. As our scientific knowledge of taxonomy improves, the identity of good specimens can be re-determined. Since these collections are authenticated vouchers for the original project, the information in that project will remain linked to the most modern taxonomic concepts via these collections.

Although it may be easier to examine an unmounted botanical specimen, normal handling easily damages dried, brittle material. Therefore, herbaria and museums affix these specimens to white mounting cards/sheets. Many of the collections held by these organizations are irreplaceable, and any serious damage would lessen their scientific value. Furthermore, herbaria and museums are custodians of these natural heritage objects on behalf of the citizens of their region. Therefore, it is useful to remember the size of the herbarium sheet that will be used to mount the specimen. Since most herbarium sheets are about 430mm long and 280mm wide (or larger), botanical specimens about 300mm long make suitable specimens of most species.

When possible, collect the entire plant or at least a portion of a plant when it is much large than a typical herbarium sheet. A typical branch or portion of the stem, about 200–300mm long, showing the leaves in position and with flowers and/or fruits (both if possible), should be collected: these are the characteristics that are traditionally used for determining the identity of a plant. If open flowers are not available, then flowers buds should be included. If variation in leaf form is apparent, specimens should include different parts of the same plant to represent this variation. Seeds can be useful in the identification of plants and should be included, if available.

For plants with large leaves or massive fruits, do not limit what makes up the collection because it may be difficult and/or take a great deal of time. It is more important to have a complete, useful specimen than to conform to arbitrary rules (but see below about storage of large specimens).

11.2.1 What to collect

The features most important for identification vary between different plant groups. The major plant groups
p. 255 and some specific requirements for collecting these groups are listed below. ↳

Figure 11.1.

Selecting material from a flowering branch for the botanical specimen using secateurs.

11.2.1.1 Vascular plants

Vascular plants (also known as ‘higher plants’) are plants that have specialized tissues (often woody) for conducting water, minerals, and photosynthetic products through the plant. Vascular plants include the ferns, clubmosses, flowering plants, and conifers. There are many useful publications on the collection of vascular plants (see references cited in Taylor 1990). Additional practical advice for working in tropical regions is provided by Hyland (1972), Kajewski (1933), Mori (1984).

(i) Ferns.

It is important to make sure that the specimen being collected is fertile (spore-bearing) (Bridson and Forman 1998). The spores are arranged in sporangia which differ in position and appearance in the various groups of ferns. In the majority of ferns the sporangia occur on the margin or on the lower (abaxial) surface
p. 256 of 'leaves' (fronds). Therefore, specimens must include the sporangia (if ↳ separate from the fronds), or fertile (spore-bearing) fronds and sterile fronds, as well as part of the rhizome (if present) or base of stem (stipe). For tree ferns, a portion of a fertile frond and the base of the frond stalk bearing scales or hairs must be collected.

(ii) Herbs.

When dealing with small herbs the entire plant should be collected. Herbs with underground storage organs should be dug up complete with storage organs. However, if the plant is uncommon, make notes on the characteristics of these basal parts, including measurements and drawings, and leave them to shoot again in the following year. This is especially important in the case of orchids and rare species.

(iii) Grasses.

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

(iv) Bamboos.

Bamboos are variously woody, temperate, or tropical grasses that have jointed and often hollow stems. They can be identified from sterile material (lacking flowers and fruits); however, reproductive structures have traditionally been used for identification purposes.

The parts of the plant that are essential for identification are discussed in Soderstrom and Young (1983) and Womersley (1969). The features include:

1. Culm sheaths: at least two complete sheaths, from about the fifth node from base of culm ('stem') and several mature sheaths from mid-culm nodes. Attach to each of these sheaths a label that records the node from which they were collected. If too large, then cut or fold as necessary. If a sheath cannot be flattened without fracturing, then roll and do not press. However, it is necessary to protect the fragile apex of the sheath by enclosing the rolled sheath with paper.

2. Leafy twigs: include large and small leaves, both young and old. Since the leaves often begin to 'curl' soon after collecting, it is advisable to press the leaves as quickly as possible.

3. Section of branch: at least one typical section of a branch (15–18cm long) from about half-way along culm.

4. Culm nodes and internodes: a segment of mature-sized culm, including the fourth and fifth nodes above the ground.

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5. ↳ Rhizome: at least one complete example of the structural unit, preferably two or more units that show the branching habit of the rhizome (the horizontal, usually underground stem that often sends out roots and shoots). Trim off roots.

6. Flowering branches: although rarely present in bamboos, collect enough to show the habit, leaf arrangement and density, and stages of development. Collect fruits if present, making sure they are not lost (during pressing and drying) because they readily detach from the plant.

Photographs, sketches, and additional notes complement the botanical specimen and are extremely helpful when identifying the plant.

(v) Trees and shrubs.

As for all plants that are too large to fit onto the herbarium sheet, additional information about the tree or shrub being gathered must be recorded at the time of collection. When collecting trees, the collector's notes should describe the colour and type of bark (e.g. rough, smooth, stringy, or fibrous) and if rough, how far it extends (e.g. over base of trunk only, also on main branches, and/or on fine twigs); sometimes it may be appropriate to collect a wood and bark sample as an ancillary collection. As for other flowering plants, flowers, including flowering buds and fruits, should all be collected if available. Since there may be differences between the types of leaves present on a plant, the collection of adult and juvenile leaves, and sun and shade leaves should be observed and collected if different, or described if any of these cannot be obtained. Since many plants are deciduous, the flowers and fruits may be present when leaves are absent. This should be recorded in the collector's field notes. Each separate stage of the plant's lifecycle can be collected independently and treated as separate specimens, but from the same plant. The bark features may not be as important for the identification of large shrubs, but it is always good practice to record this information at the time of collection.

(vi) Succulents.

The tissues of succulents and fleshy plants (e.g. cacti, agaves, aloes, bromeliads) usually contain large amounts of water, and some even tend to retain water during the pressing and drying process. There are several techniques used to overcome this problem (Victor et al. 2004):

1. Remove inner tissue: the specimen can be cut longitudinally or transversely so that the fleshy inner tissues can be removed before pressing. This method is used for *Aloe* species and many species of cacti.

2. Hot water/liquid treatment. Submerge the plant material in very hot water or in methylated spirits, petrol or even vinegar. Prior to submersion, pierce material with a needle to allow ready penetration of liquid.

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3. ↳ Freezer/microwave: place unpressed material in a freezer for two days and then place in microwave for periods of 5–10 seconds and then check, repeat as necessary until material dried (Leuenberger 1982).

Fleshy flowers can be prepared for pressing and drying by cutting longitudinally, separating the two halves on white card (some prefer moistened gummed paper—Victor et al. 2004), cover with wax paper and enclose in a sheet of newspaper and then press with the remainder of the collection.

There are many excellent references on pressing and drying succulents that should be consulted for detailed information (e.g. De Langhe 1972; Logan 1986; Croat 1985; Griffiths 1907; Jorgensen 1972; MacDougall 1947).

(vii) Plants with large inflorescences or other large parts.

When collecting plants such as agaves, palms, pandans (Stone 1983), or bananas, the lengths of the flowering and non-flowering parts of the inflorescences and trunk heights should be noted. For plants such as large-leaved palms, cycads, bananas, and aroids, the smallest complete leaf is often many times larger than the standard sheet. There are two collection and storage methods for such plants. One technique is to cut the leaf into numerous (carefully numbered) portions which are attached to multiple herbarium sheets in the herbarium or museum. This has the advantage of not requiring alternative storage areas. Disadvantages include the need for additional documentation, preferably including photographs, and the difficulty of relating the specimen to the living plant. The alternative technique is to collect the entire leaf and to provide special separate storage for such material. The main disadvantages of this technique are that the material is difficult to handle in the field (to press and dry) and greater storage space is required.

(viii) Bananas.

The collection of giant herbaceous plants, like bananas, some aroids, and heliconias, is always difficult. As for all large plants, it is impossible to collect the entire banana (*Musa*) plant as a herbarium specimen. Photographs, sketches, and extensive detailed notes are essential. Record the following features:

- Pseudostem ('stem'): suckering habit, height, colour, degree of waxiness, colour of exudates (sap), height, and diameter.
- Leaves: held erect or spreading, length and width of lamina (size of leaf blade), length of petiole (stalk of leaf), including leaf colour, waxiness, and markings), margin of sheath (lower part of leaf that more or less surrounds the stem).
- Fruit clusters: banana fruit grow in hanging clusters, with fruit arranged in a 'hand', and several hands form a bunch. Record if the bunches are erect, semi-pendulous, or pendulous, number of hands per bunch, whether hands compact or distant from each other, number of 'fingers' (individual fruits per hand), and whether fingers are close together or distant.

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- ↳ Fingers: curved upwards or downward, length, diameter, cylindrical or angular at maturity, colour of skin when immature and mature, whether skin peels off mature fingers, colour of pulp surrounding seeds.
- Rachis: the axis of the fruiting bunch. Record if rachis is directly pendulous, slightly S-shaped, or markedly so.
- Male bud: occurs at the end of the rachis. Record shape, size, and colour (photograph and make a drawing). Also record whether or not the bracts overlap each other.

To make adequate herbarium specimens from bananas is extremely difficult, but the best method is to store most material, except for leaf samples, in bottles containing solutions of 70 per cent ethanol or methylated spirit. Removing some of the bracts from female and male flowers assists with the penetration of the preserving liquid.

(ix) Palms.

When collecting palms it is important to realize that ample time is required to prepare a good herbarium specimen, especially of large tree palms. Since the plant is too large to collect in its entirety, the collection should represent the living plant in such a way that someone else can imagine what the palm looked like from the material that you collected (Dransfield 1986). As for other flowering plants, it is generally not sufficient to collect sterile specimens for the purpose of identification. However, sterile material of rattans (climbing palms) has many useful features for identification purposes in the leaf and leaf sheath (Baker and Dransfield 2006). The features to collect include:

- A section of stem: if stem is slender then take a sample of stem. However, if large, cut off a thin strip of the stem's outer surface.
- Leaf sheath: take an entire sheath and split it down the middle, cut into fragments if very large, representing base and apex (always clearly label all parts).
- Leaf: remove an entire leaf, or if large, then cut into smaller sections representing base of petiole (stalk of leaf), basal part of leaf (often first leaflets) plus apex of petiole, a middle section of leaf with axis (rachis), and then apex. Label all parts carefully. The leaflets from one side of the leaf can be removed if the leaf is very large.
- Inflorescences (arrangement of flowers): if large, then cut inflorescence into sections and provide a basal part, middle, and apical portions.
- Flowers and fruits: good flowers and fruits are required. You may not be able to get both from the same plant. Furthermore, fruits and seeds may be plentiful on the ground. Collect germinating seedlings as these can be useful.
- Rattans (climbing palms): collect the climbing 'tendrils' and record if they arise from the leaf apex or the leaf sheath. Do not attempt to remove the sheath from the stem.

(x) Aquatic plants.

Generally the entire plant should be collected, if possible. As for terrestrial plants, aquatic vascular plants
p. 260 usually require flowers and mature ↳ fruits for identification; others require the rhizomes (e.g. water lilies) and rootstock; since immature and/or submerged leaves are different from mature and/or emergent or floating leaves, these should be collected as well. Remember that aquatic plants will wilt very quickly once removed from the water. Keep them in a bag or bucket with some water at all times until ready for pressing.

Some very small plants, like the floating duckweed (*Lemna*) and floating fern (*Azolla*), do not make very satisfactory pressed and dried specimens, but these can be placed between paper towelling (very absorbent paper) for pressing and drying, to produce reasonable specimens. Plants which contain a lot of mucilage are better pressed between sheets of greaseproof paper (Leach and Osborne 1985). Many publications that provided useful information on collecting aquatic plants (e.g. Haynes 1984; Ceska and Ceska 1986; Fish 1999).

11.2.1.2 Non-vascular plants

Non-vascular plants ('lower plants') are plants that lack specialized vascular tissue. These plants have no true roots, stems, or leaves; however, they often have structures that are superficially similar. Non-vascular plants include two distantly related groups, namely, Bryophytes (Lepp 2008+) and Algae (green algae) (Entwisle and Yee 2000–; Entwisle et al. 1997; Millar 1999–).

(i) Bryophytes (mosses, liverworts, hornworts) and lichens.

Bryophytes and lichens should *not be pressed* when collected because the pressing process distorts the form of the plant and destroys some of the critical morphological features.

Detach the specimen from the substrate by hand or by use of a knife blade, taking care to include a narrow layer of soil or bark underneath the plant. Collecting lichens that grow on rocks can be more difficult, and may require some of the rock to be chipped away with a hammer or geological pick.

Place the specimen in a brown paper bag—never use polythene bags. However, remember that some bryophytes, for examples species of peat moss (*Sphagnum*), may contain large amounts of water. Remove as much of the water as possible by gently squeezing prior to placing specimen in paper bag. To make sure that the plants dry quickly, it is usually necessary to open the bags to the air or fan (if available) as much as possible. This is especially true in the wet tropics, where it is often difficult to dry any type of botanical collection. Once the specimen has dried, remove the excess soil and place the specimen back in an envelope and keep in a dry place until ready for despatch to an herbarium for identification.

(ii) Algae.

Freshwater algae

Large algae and any attached microalgae can be collected by hand or with a knife, more easily in shallow water than deep. However, the risks associated with tropical waters, such as larvae of parasites, crocodiles,
p. 261 and other ↳ predatory animals, strongly indicate the use of various mechanical aids (Fosberg and Sachet 1965). The collection should include at least part of the substrate (e.g. rock, plant, or wood) if possible. When searching for freshwater algae, it is important to search all habitats in the body of water being investigated, including the edge of stones in fast-flowing water, surface of aquatic plants, dam walls, and any floating debris. In running or slightly turbid waters, a simple viewing box made from transparent Perspex enables attached algae to be more easily observed (Entwisle and Yee 2000–). A 10× hand lens is often required to determine if material is fertile. Microscopic floating algae (phytoplankton) can be collected with a mesh net (e.g. with 25–30 µm pores) or, if present in sufficient quantity (i.e. colouring the water), by simply scooping a jar through the water. Water samples can be left overnight allowing the algae to settle and concentrate on bottom of container. Squeezing peat moss (*Sphagnum*) and other mosses, or some aquatic flowering plants is a good way to collect a large number of species (Entwisle and Yee 2000–). Algae growing on soil are difficult to collect and study, many requiring culturing before sufficient materials are available for identification. An understanding of the morphology of freshwater algae is very useful when making collections (e.g. Wehr and Sheath 2003).

In addition to the standard information provided by the collector (see below), the field notes should include information on: whether the water is saline, brackish, or fresh; whether the collection site is terrestrial or a river, stream, or lake; whether the alga is submerged during water level fluctuations or floods; whether the water is muddy or polluted; whether the alga is free-floating or attached, and if the latter, the type of substrate to which it is attached; and the colour, texture, and size of the alga.

Initially, algae can be stored in a container (bucket, jar, bottle, or plastic bag), with some water from the collecting site. The container should be left open or only half filled with liquid; wide, shallow containers are better than narrow, deep jars. For long-term storage, specimens can be preserved in liquid (Entwisle and Yee 2000–; Entwisle et al. 1997), dried, and/or made into a permanent microscope mount. Seek advice from professional phycologists for specific advice and instruction.

Marine algae

In general, the collection of marine algae (seaweeds) requires specialist diving skills. However, the collection of littoral algae can be undertaken by most people, with due awareness of the risks inherent within the marine environment. Algae that occur in deeper waters can only be collected by snorkelling and/or scuba diving. Although many collections can be made by hand, tools are generally essential. Collected specimens of different seaweeds should be kept separate while collecting. The specimens need to be fertile (with reproductive structures) because these features are required for identification. These reproductive structures are sometimes visible without a hand lens, because they have different coloration
p. 262 on ↳ the seaweeds, either on the surface or on special branches of the thalli (body of the alga) (National Taiwan Museum 2006). In addition, knowing the lifecycle of seaweeds can help with the identification of the species (Millar 1999–) and can assist the collector when selecting appropriate specimens. Hence, it is important to observe and record all details about the form, colours, numbers, substrate, location, and the surrounding environment.

As for freshwater algae, storage and preservation of marine algae require specialized treatment. Therefore, advice from experts should be sought on how to manage the specimens of different algal groups. Freshly collected algae should be kept cool after they are placed in plastic bags or plastic bottles (National Taiwan Museum 2006).

(iii) Fungi.

When collecting fungi, it is important to place the specimens in a flat-bottomed basket or open box to minimize the amount of damage that may be caused to these delicate specimens. Each collection should be carefully wrapped in newspaper or, especially for the smaller and more delicate species and microfungi, placed in individual containers. Never use polythene bags. For agarics, it is essential to collect the entire 'fruiting body' (what most people think of as a mushroom, puffball, or toadstool), the base of the stipe ('stem'), and the remains (if any) of the cup- or sac-like structure (volva) occurring at the base of the stipe of agarics. A spore-print from at least one specimen of each collection is useful for larger fungi (see Bridson and Forman 1998; Major 1975).

11.2.2 Collecting plant disease specimens

When collecting plant material that appears to be affected by diseases, such as rusts, smuts, leaf spot, galls, cankers, and other diseases, these collections can be pressed and dried (see §11.5). It is important to include a collection of the diseased (host) plant that is adequate for identification. Make sure that as many identifiable stages of the disease are represented by the collection. Since it is important to have some understanding of the possible type of disease affecting the plant, further detailed information should be sought (e.g. Schubert et al. 1999 and literature cited therein).

11.2.3 Collecting living material

Living material may be required for cultivation in botanic gardens and gardens of research institutions (Bridson and Forman 1998). Increasingly, these collections are required for conservation purposes by having a readily available source of viable seeds and/or vegetative material for use in habitat restoration
p. 263 (Offord and North 2 ↳ 009). Cryopreservation of germplasm (seeds, embryos, pollen, and other botanical tissue) at −130 to −196 °C in liquid nitrogen is a method of long-term storage of botanical material for conservation purposes (Hamilton et al. 2009). If requested to collect botanical material for cryopreservation, then detailed instruction would need to be provided prior to making the collection. However, as for collecting herbarium specimens, the collection of living plant material from natural communities represents a potential threat to rare species as well as local populations of more common plants. In general, the collection of living material is not encouraged unless there is an important reason to do so and the person making the collection is adequately proficient in both collecting living material and in maintaining this living material after collection. Note that sale or trade of living material is equally strongly controlled by many regulations. The following are critical points to remember when collecting plants (for further details see §11.6).

- Obtain collecting permits before collecting any material (see §11.6.1) and permission of the landowner before collecting on private land. Report illegal or unauthorized collecting that you encounter to the appropriate authorities.
- If you encounter a plant with which you are not familiar, assume it is rare and refrain from collecting until you have ascertained that it is not rare.
- Collect discriminatingly—even in large populations. Collect only the amount of material you will actually make use of. Care properly for any material you collect —do not let it go to waste.
- Avoid unnecessary damage to sites and their aesthetic values. Avoid frequent visits to the same sites.

If you must collect living plants from natural communities for scientific research, collect in a manner least likely to damage the wild population. Make sure that you understand why the material is required. Although pressed and dried herbarium voucher material can often be prepared with relatively little prior skill, always seek advice and instruction on how to best collect and store the living material.

In order of general preference, collect:

- Seeds, if abundant (see Gunn et al. 2004; Schmidt 2000). For information on how to collect seeds that represent the genetic variation of a species and hence are suitable for long-term storage, see Bridson and Forman (1998), Cochrane et al. (2009), Gunn et al. (2004), Offord and Meagher (2009).
- Cuttings or other plant parts: when plants can be collected and rapidly transported to plant nursery, it is convenient to collect cutting material. Hardwood cuttings of temperate and some tropical shrubs is an inexpensive and simple method for collecting material for propagation. In general, choose shoots with a section of older wood, last season's growth, and a few centimetres long. Softwood cuttings are not as resilient (Bridson and Forman 1998). Both types of cuttings should be dispatched as soon as possible by air, wrapped in moist newspaper and enclosed within a padded envelope.
- p. 264 ↳ Whole plants: this collecting technique is required for plants with recalcitrant seeds and/or herbaceous material that are not readily propagated from cuttings. Seedlings should be carefully packed, with moist shredded paper, preferably enclosed in an ethylene absorption plastic bag; a normal plastic bag can be used but should be opened every evening to allow the ethylene to escape, to reduce or avoid damage to the underground parts (roots, runners, or stolons). It is usually essential that cuttings are dispatched by air freight.

- Collect most material: leave behind some reproductive or regenerative parts such as fruits, roots, or rhizomes (Washington Native Plant Society 2007). This is the least satisfactory type of collecting and should be avoided whenever possible.

11.2.4 How much material to collect?

The herbaria and museums are part of an international network of scientists who share botanical specimens, knowledge, and information about the flora of the world. Since no single organization can hope to have scientists who are specialists on the identification and taxonomy of every botanical group, these organizations donate replicate material of their collections to other organizations so that particular experts can provide expert determinations. Therefore, it is important to always collect more than one sample of each collection so that enough material is available as donations. Three to five replicate collections (all with the same collection number) are usually sufficient unless requested otherwise. Of course, this may not be appropriate when collecting rare and vulnerable species.

11.2.5 Label your collections

Each collection and each separate part of a collection should be labelled with a tag (e.g. a jeweler's tag) on which your name and unique collection number is written (preferably in pencil, never in ink that is not waterproof or resistant to methylated spirits, 70 per cent ethanol, or other solutions that may be used to preserve botanical collections). A personal collection-numbering series is worth beginning, even if you do not intend to collect many organisms. A simple numbering series, starting at one (1), is preferable. Once you have started your own collection-numbering series, continue it for all future collections, in numerical order. Avoid the inclusion of the collection date or some other prefix or suffix: these tend to be confusing for others to refer to and frequent errors are made when referring to these collections. The different parts of single gathering (collection), as for collections of large plants, should all be referred to by your name and the same collection number.

11.3 Field Notes and Observations

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The most important rule to following when deciding on what should be recorded at the time of collection is:

> If the feature or information is not present on the specimen or is distorted after it has been pressed and dried, then it should be recorded by the collector.

Botanical features that change and so must be recorded include:

- Colours: these often change during the drying process.
- Shape and sizes of fleshy parts: these change dramatically when dried and pressed.
- Features of delicate flowers may become detached and/or lost, or get changed by the pressing and drying process—for example, the shape of complex irregular or zygomorphic flowers, such as orchids, legumes, and labiates, may become very distorted and so difficult to evaluate once dried. These problems can be at least partly overcome if one or two flowers are carefully opened along one side and flattened so that the inner features are displayed.

11.3.1 What to include in your field notes?

- Collector's name(s) and number: always remember to include the names of any local people who assist you with the collection of the specimen. However, remember that the numbering series belongs to the primary collector; the other people are regarded as secondary collectors.
- Date of collection: if you are aware that the flowers of the plant you are collecting do not last for the full day (e.g. some species of *Xyris* and some aquatics), then record the time of collection as well.
- Locality of collection: the descriptive and spatial coordinates of the locality from where the plant was collected. Include:
  - Country.
  - Province/State/Territory—as formally recognized within the country.
  - Districts/SubDistricts—if formally recognized.
  - Special geographic areas—such as Conservation Parks, National Parks and other special reserves.
  - Description of specific locality—e.g. '5km W of Nauti, on road to Aseki'; '300m S of "Resting Place 2" on walking trail to summit of Mt Wilhelm'. Avoid imprecise descriptions of the locality like, 'near Wanang River', 'between Wail and Goroke', 'N of Ciawi'. Remember that the descriptive locality information is often more useful than anything else for relocating the organism.

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- ↳ Altitude (m) and how measured, plus degree of precision (also in metres).
- Depth (m) and how measured—for aquatic plants, plus degree of precision (metres).
- Latitude and longitude (or geographical coordinates—eastings and northings): these geocodes should describe the locality as accurately as possible so that the collection site and the plant can be re-visited if necessary. The method used to generate the spatial geocode should be provided (e.g. GPS, Map, Gazetteer), the level of uncertainty of the geocode (in metres), and most importantly, the datum used for generating these spatial geocodes (most commonly, the datum for a GPS should now be set to WGS84). If maps are used to generate the geocode, then the map type, scale, map name, and map number should be provided.
- Habitat—a description of the specific habitat, including vegetation structure and composition (e.g. forest type and two or three of the names of the dominant species), substrate—rock and soil type (including name of host plant for climbers, epiphytes, and parasites).
- Habit notes: a description of the appearance of the plant are important for identification; features that may be distorted in the pressing and drying process or are not represented by the specimen collected should be recorded. Comments on the status of the plant at the collection site should indicate whether or not the plant is thought to be naturally occurring or has been introduced, and whether or not the plant is cultivated.
- Vernacular names and plant uses: vernacular names used by the local people (including the name of the language group). The name of the informant as well as his/her language group should be recorded. An audio recording of the vernacular name is preferable, but is rarely done by botanical collectors. If the plant is used by the local people, then this should be recorded, noting which part of the plant and what its uses are.

11.3.2 How useful are photographs for identification?

Photographs never replace the need for good-quality herbarium collections. Photographs and drawings often assist the person identifying a specimen because the images can better represent features of habit, presentation of plant parts, shape, texture, and colour than is provided by the preserved specimen or the collector's notes. However, the specimen is required as an authoritative voucher of the species. Therefore, photographs and drawings should be regarded as secondary and complementary material to the botanical collection.

Photographs of whole plant or parts of the plant may be used to supplement the information included in the
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notes (a note in the field notebook 'photo taken' is ↳ then useful). If additional material (e.g. photographs, separate seeds, wood, and methylated spirit- or ethanol-preserved collection) is also gathered, it should also be numbered with the same collection number as all other parts of the collection.

Figure 11.2.

A sample page from a collecting field book showing the usual fields of information recorded when collecting botanical specimens. Other possible types of material associated with collection are listed in textbox.

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11.4 Electronic Data

Increasingly, computer systems are being used to store and manage biological data. Develop a data field-based system, such as an electronic database or spreadsheet, to record and store botanical collection data. Personal digital assistant (PDA) handheld computers are also available for direct data entry. Make sure that you enter the information into the data fields (spreadsheet cells) in a consistent manner, according to the data definition of each field/cell. Always be careful with spelling. For information of data exchange standards refer to Conn (1996) and for more recent versions of this standard, refer to HISPID (2007–). Provide these data to the agency receiving your botanical collections. This avoid data processing errors caused by rekeying information, and will make these data part of a much larger national and/or international biodiversity data network.

11.5 Pressing and Drying Plants

Once the botanical material has been collected, labelled with the collector's name and collecting number, and the field notes have been completed, the next task is to flatten (press) and dry the material as soon as possible (with exceptions discussed above). The selected specimen is inserted into folded newspaper (Fig. 11.3) or into special drying paper with good absorbing properties. If it is not possible to press specimens in the field because of insufficient time or the inaccessibility of the collecting location, then the collections can be sealed within a plastic bag for a short period of time, usually less than one day, without their deteriorating noticeably. In dry conditions, the collections should be moistened with a small amount of water to minimize dehydration. Individual collections can also be rolled in moistened newspaper and sealed in plastic bags for a short time, mostly for less than twelve hours, and then pressed and dried. Botanical specimens should also be kept cool if they are not pressed and dried immediately. However, it should be noted that many plants, particularly some flowers, are not robust enough to survive any delay in pressing. Every effort must be made to ensure that the separate parts of each collection are kept together until they are pressed.

The reasons for pressing and drying botanical material are:

- to preserve the material for future study;
- to prevent wilting and minimize distortion;
- to not only flatten the material so that less space is required for storage, but to protect delicate features that are generally less likely to be damaged in pressed specimens.

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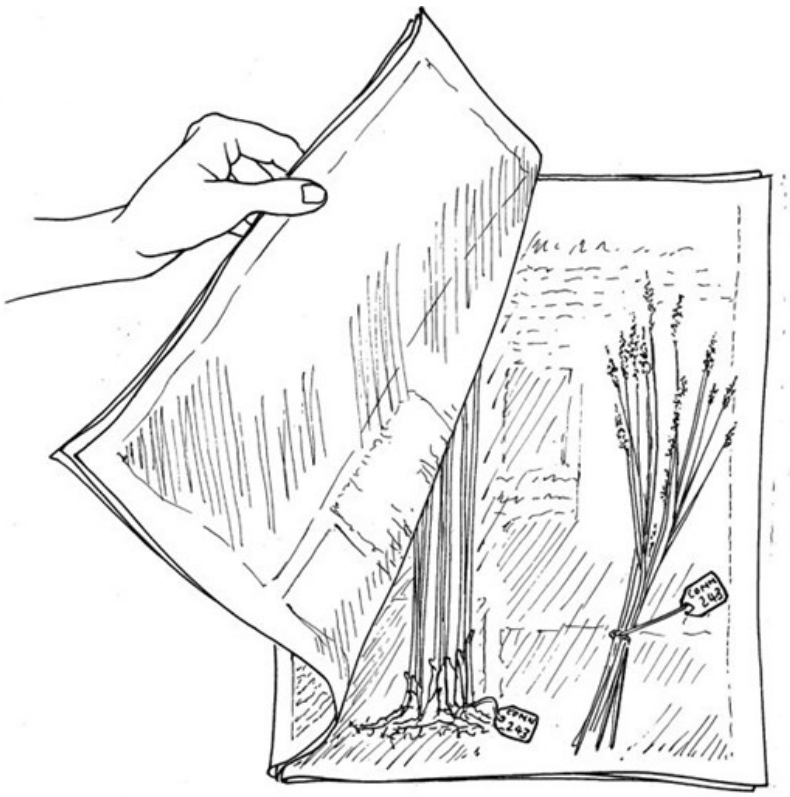
Remember: the drying papers must be inspected and changed regularly, particularly during the first few days of pressing. This is very important in humid environments and for specimens that have a high moisture content.

Figure 11.3.



Plant specimen inserted into folded newspaper or special drying paper with good absorbing properties. All specimens of the collections must be labelled with the collector's name and collection number.

11.5.1 The plant press

A plant press consists of two strong, rigid lattice frames, made either of wood or of metal that is slightly larger than a standard herbarium sheet (Fig. 11.4). The botanical specimens are enclosed in drying paper.
p. 270 Newspaper is usually used because it is inexpensive, normally plentiful, and has adequate absorptive ↳ properties. Place the specimen in one folded sheet of newspaper and then enclose this in another folded sheet of newspaper that covers the opening of the first (Fig. 11.4). In this way, the specimen is more or less held within the two sheets. Corrugated cardboard or metal sheets (Nichols and St John 1918; Stevens 1926) are often used as ventilators to allow airflow across and between the specimens to assist the drying process. The press is usually held together and tightened by two expandable straps or by small ropes (Fig. 11.4). Polyurethane foam is also useful to maintain more or less even pressure on bulky specimens (Chmielewski and Ringius 1986).

Attention should be given to the pressing process: once a specimen is pressed and dried, its overall shape cannot be readily altered without damaging the material. Therefore, position specimens in such a manner so that the different features are clearly visible. Leaves should show both surfaces, so make sure that some leaves have their upper (adaxial) surface showing while the lower (abaxial) surface of other leaves face the opposite way. Likewise, turn some flowers so that both sides are visible when pressed. Spread the lobes of leaves, flowering and fruiting structures, and flower parts so as to show the shape and arrangement of these features more clearly. Arrange each specimen within the press so as to minimize any damage to other collections. Reduce the bulk of specimens with large fruits, thick stems, or underground parts by splitting or cutting away sections. The number of leaves, flowers, and fruits can be reduced if they obscure important features—but always leave sufficient material to make it clear that something has been removed.

A lightweight, temporary alternative to a field press is an A4-size notebook. A more robust temporary press can also be made from interwoven strips of bamboo.

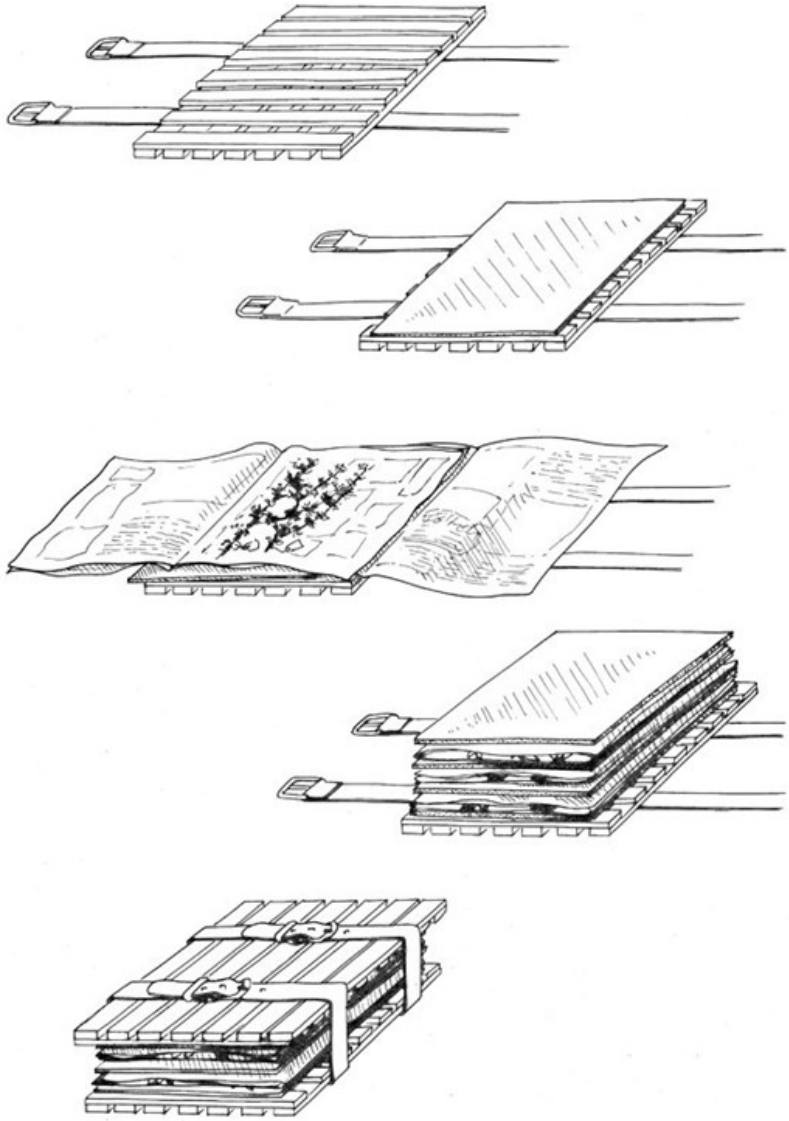
Remember: after twelve to twenty-four hours the specimens in the press should be examined and rearranged if necessary to improve the presentation of the botanical material.

11.5.2 Drying botanical specimens

In dry climates, drying the specimens is usually relatively easy. Artificial heat is usually not required. However, there must be sufficient airflow between the specimens in the press to ensure that the samples dry quickly, otherwise the specimens may become mouldy. Therefore, even in dry environments, the collections should be checked daily and any damp sheets/newspaper should be replaced by dry sheets (Victor et al. 2004). This method is not suitable in the wet humid tropics, where the drying of collections and keeping them dry can be very challenging. Several useful publications suggest excellent solutions to drying specimens in the wet tropics (e.g. Beard 1968; De Wit 1980; Fuller and Barbe 1981). In all instances, the best
p. 271 policy is to ↳

p. 272 ↳
get material to a herbarium or museum as quickly as possible, because they have the appropriate facilities and resources to deal with these materials.

Figure 11.4.



Plant specimens being placed in a plant press for drying and pressing. The correct pressing of specimens is very important. The shorter the time between collecting of a specimen and pressing, the better the resulting herbarium specimen. Note: place a cardboard sheet next to the frame of the plant press. Cardboard between the drying sheets surrounding each collection, or between separate specimens of a collection, gives the best results.

11.5.3 Field drying

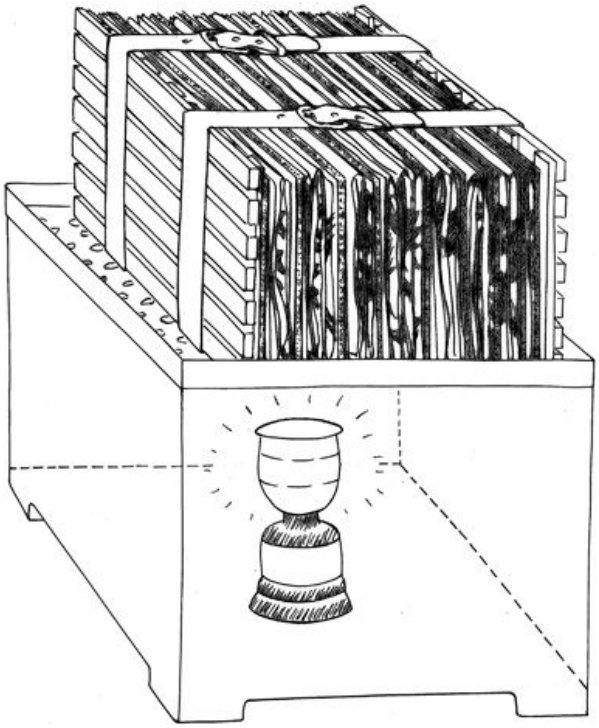
The drying of material while in the field is often difficult unless the appropriate techniques and equipment is used. Field driers that consist of a source of heat and a frame to enclose the heater and to support the collecting press of specimens are required. Pressurized lamps (kerosene or gas lamps) are very effective and have the benefit of providing light in the camp (Fig. 11.5). If electricity is available, then a hot plate, heating fan (Jenne 1968), or set of light globes makes an effective plant drier (Gates 1950; Hale 1976; Van der Merwe and Grobler 1969; Womersley 1969). Heat can be provided from naked flames produced by gas rings (Halle 1961; Croat 1979) or hot coals (Victor et al. 2004), but are not recommended, because dried pieces of plant material may fall into the heat source and result in a devastating fire. However, it must be remembered that whatever the source of heat, the risk of fire is always a possibility. Care must be taken at all times. If the field trip involves travelling by motor vehicle, then in dry environments, plant presses containing the botanical specimens can be attached to the roof-rack of a moving vehicle. The airflow through the ends of the press will effectively dry the specimens. However, the presses must be secure and frequently checked to make sure that they do not become loose. The consequences of an unsecured press on a travelling vehicle are usually disastrous for the specimens!

11.5.4 Field preservatives

Botanical specimens frequently begin to deteriorate in a plant press if they are not dried promptly. This is particularly a problem with specimens from the wet humid tropics where the leaves frequently fall off and/or the specimens become mouldy. This may happen within a couple of days of collecting. If it is not possible to dry botanical specimens in the field, then there are two preservative liquids that are available which can prevent mould developing in freshly collected botanical specimens, namely methylated spirits (readily available) and 70 per cent ethyl alcohol (with restricted availability). Previously a solution of formaldehyde (known as formalin) was also used, but the previous two liquids are safer to use.

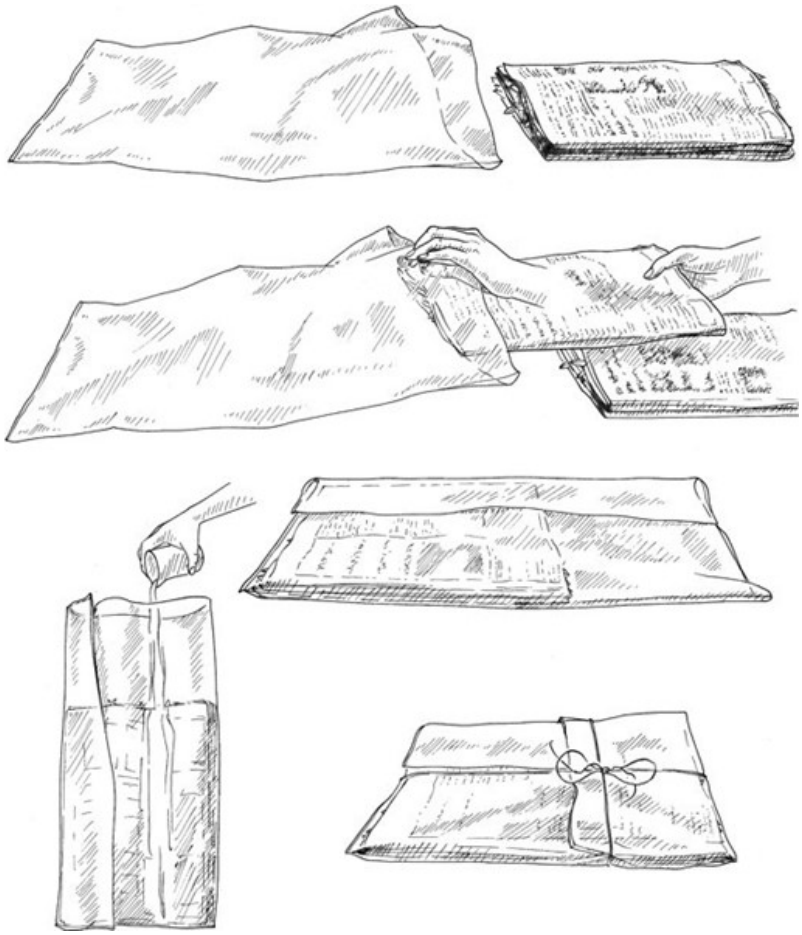
The botanical collections are pressed for up to twelve hours. After this, the specimens are removed from the press, with any damp enclosing newspapers replaced with dry sheets of newspaper. The collections are inserted into a polythene bag or tube (Fig. 11.6). When all the specimens are in the bag or tube (with one end
p. 273 of tube enclosed and sealed with alcohol-resistant tape), add about three average- ↳ sized cups of methylated spirit or ethyl alcohol solution (Fig. 11.6). Spread the preservative evenly across the open end of specimens, ensuring that sufficient liquid has soaked throughout the material. Since the preservation is effected by the vapor of methylated spirit or ethyl alcohol, it is not necessary that any free liquid be present. Close the open end of tube/bag thoroughly and tie the bundle with a simple crossed string (Figure 11.6)
p. 274 (Womersley 1969). ↳

Figure 11.5.



A simple plant drier using a pressurized lamp, with plant pressed firmly strapped and placed on one side to allow maximum airflow between the specimens. If the sides of the box/stand enclosing the lamp are of clear plastic, then light is available for other camp activities.

Figure 11.6.



Partially pressed specimens can be preserved for later drying by sealing specimens and drying papers in a plastic bag after saturating the papers with methylated spirit or ethyl alcohol. These sealed bags of specimens can usually be kept for two or three months without deterioration. However, the specimens should be sent to a herbarium as soon as possible so that the drying process can be completed.

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11.6 What you Need for Plant Collecting: Pre-Fieldwork Planning

Botanical collecting in foreign countries, especially in remote areas, requires considerable pre-fieldwork planning to ensure that all the necessary collecting permits and other legal documents have been obtained, appropriate equipment is available, all the personnel have been fully briefed on the social and civil status of the area being visited, and the physical and health risks have been thoroughly assessed. Although some aspects of this planning may not be as necessary when undertaking field studies within the collector's own country, the following points should be considered carefully prior to undertaking any field studies. Cochrane et al. (2009) provide a ‘collection checklist’ that summarizes important issues to be considered when undertaking botanical collecting.

11.6.1 Plant collecting permit

Most countries are signatories to the International Convention on Biological Diversity (CBD 1993–). Therefore, it is advisable to be fully aware of the laws applicable to the area from which you wish to collect and to obtain the necessary approval and permits. You can usually obtain collecting permits from government departments that are responsible for environment management within the area to be visited. Contact the nearest major herbarium or museum (see Thiers 1997– for contact information) and seek their advice prior to making the collection. Remember, in many countries, separate permits are required for different States or Provinces as well as separate permits for different types of management areas (e.g. conservation parks, national parks, and nature reserves). Finally, remember to obtain permission from local landowners or custodians so that you can undertake field studies on their land.

11.6.1.1 Special permits

Phytosanitary permits will probably be needed when transporting plants across borders of different countries. These permits must be obtained from the country of origin.

The Convention on International Trade in Endangered Species (CITES) legislation regulates and controls the international trade in material obtained from plants considered to be endangered. Remember: scientific material is not exempt from CITES regulations. Therefore, CITES-listed plants require a *CITES export permit* from the country of origin as well as a *CITES import permit* from the authority ↳ (herbarium or museum) receiving the material. Since not all botanical authorities are registered as an agency approved to receive CITES material, it is important to verify that your collections are being sent to a herbarium or museum that is legally allowed to receive these specimens.

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11.6.2 Pre-planning meeting: field hazard assessment

Possibly the most important aspect of field studies is the recognition, by all members of the field team, of the possible hazards that they are likely to encounter in the field. Careful planning and preparation can avoid many of the potential difficulties of working in remote areas. It is recommended that a ‘Field Hazard Assessment’ document be completed prior to any fieldwork. A copy of the completed document must be held by the principal organization involved with the work. This document should form the basis of a post-fieldwork evaluation of all aspects of the field study.

The topics and issues that should be covered by this document should include the names of participants, including Team Leader; description of project and area to be visited; dates when field team expected to be at specified localities; and insurance arrangements, especially for non-staff.

11.6.3 Emergency aids and contact schedule

Mobile/cell telephone numbers of all team members must be listed and held by all members of the team. However, since the work is in remote areas, a review of any expected areas of non-coverage is essential. If satellite telephones are to be used (and this is strongly recommended for remote areas), all members of the team need to be trained in their use. Likewise, if a two-way radio is to be used, then all members must be familiar with its operation.

Each member of the team must carry matches (in a water-proof container) or a fire lighting flint, a watch (for estimating time) and/or compass for estimating direction, a small reliable light (head-lamps are usually more convenient), survival blanket (especially recommended in alpine zones or high latitudes), and a whistle (for attracting attention).

11.6.3.1 Personal Locating Beacons (PLB) and Emergency Position-Indicating Radio Beacons (EPIRBS)

Emergency or radio beacons are tracking transmitters which aid in the detection and location of boats, aircraft, and people in distress. The basic purpose of the distress emergency beacon is to get people rescued
p. 277 within the first twenty-four ↳ hours following a traumatic event, when the majority of survivors can still be saved. Every botanical collecting trip, especially to remote areas, should carry an emergency beacon.

11.6.3.2 Contact arrangements

It is essential that a regular and frequent contact schedule is developed so that emergency rescue authorities can be informed of potential problems if the team fails to make contact at a designated time. The most important safety action is to ensure that people know where you are planning to be and where you actually are so that they can monitor the progress of the fieldwork. Therefore, make sure that there is a reliable contact person that the field team can contact regularly. The primary organization requires agreed emergency procedures and protocols that will be activated when there has been no contact with the field team after a set amount of time.

11.6.3.3 Global positioning systems and maps

A Global Positioning System (GPS) is an instrument that provides spatial coordinates and should be used in conjunction with good maps. A GPS is an excellent way of obtaining accurate coordinates for a locality, but they should not be viewed as a replacement for detailed maps. Always select the best map, at the best scale, for the area that you are visiting. In the event of an emergency, an accurate geocode reference of the team's locality will help rescue agencies to provide rapid assistance.

11.6.3.4 Vehicles to be used, vehicle recovery, and safety equipment

For motor vehicles it is important to list personnel with recovery training or substantive experience; assess physical strain risks for potential recovery tasks; list recovery equipment items being taken, such as gloves, snatch strap, tree strap, chain, shackles, spare tyres.

Other considerations include:

- Boat: record boat registration and ownership; review boat operator licences, radio skills, radio schedules, motor service status, navigational skills and equipment, safety gear, general equipment status—including mandatory certifications.
- Dive equipment and skill (review Divemaster and SCUBA certifications, equipment status—including mandatory certifications, and dive schedules with regard to personnel experience and capabilities.
- On foot: although most of the fieldwork requires considerable amount of time and often involves a considerable distance to be walked, frequently whilst carrying heavy equipment and supplies, there is a
p. 278 tendency not to consider the ↳ risks and hazards associated with this aspect of the work. Review on-track and off-track work expected, with regard to personnel experience, capabilities, and navigational skills/equipment, tree- and rock-fall hazards, and likelihood of danger from animals and poisonous plants).

When working in developing countries and remote communities, the available vehicles (including boats) may not be of a standard that will provide the maximum safety. However, it is still important to ensure that the vehicle, the driver, and the recovery equipment are as good as possible. It is also an excellent opportunity to increase the awareness of general safety issues for within-country agencies if that is

required. Well-maintained vehicles are more reliable. It is important to minimize the chances of serious breakdowns, especially in remote areas, as these can seriously impact on the safety of all participants.

11.6.3.5 First aid training and kits

Since botanical specimens are often gathered from relatively remote areas, it is important that all members of the field team have training in basic first aid techniques, and that each member always carry a first aid kit that they are familiar with. Knowledge of cardiopulmonary resuscitation and other basic remote area first aid is important. Contact an organization that presents first aid courses in your area for training and more information.

Although you may visit a remote area alone, it is never safe to do so. The field team should consist of a minimum of three people. The skills and limitations of each person should be known to all members of the team to ensure that the fieldwork can be done efficiently and safely.

11.6.3.6 Medical conditions and personal capabilities

Within the limits of privacy and with due regard for confidentiality, the field leader must be aware of any medical conditions or physical limitation of all members of the team that may affect the safety of fieldwork. The leader is responsible for providing advice to personnel should a member require medication during fieldwork. All team members must ensure that they have all of their required personal medications.

It is the leader's responsibility to make adjustments to schedules and tasks to ensure minimal stress on all personnel. Furthermore, the leader should consider the interpersonal dynamics of the team under field conditions and monitor the level of activities and rest periods accordingly.

Medical advice should be sought prior to obtaining antiseptic solutions and medicines for pain management, antihistamines, anti-emetic medicine for nausea, anti-spasmodic medicine for diarrhoea, and treatment for other medical conditions.

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11.6.3.7 Climatic hazards

An assessment of the climatic conditions of the area being visited is important. The precautions for dealing with excessive heat, humidity, aridity, cold, and/or wet weather should include having water, protective clothing, sunscreen, amongst other aids. Drinking-quality water should be available, together with water-purifying tablets when relying on local water supplies of unsatisfactory quality.

11.6.4 Working with local communities

The above points have been provided to assist researchers to work in a safe environment, according to the various regulations. However, it is equally important to ensure a respectful, equitable, and mutually beneficial relationship with local community where the field studies are being undertaken. The following suggestions are offered:

1. Plan on a medium- to long-term relationship—although one-off visits are often all that is possible, longer-term collaborations are usually more beneficial to both the researcher and the community.

2. Learn the language—being fluent in a language that allows for communication between yourself and the community is extremely beneficial to essential. Plan ahead—start learning the language at least six months in advance.

3. Obtain at least one extra bilingual dictionary to share with your field research associates if the local language is not fluently spoken by team members.

4. Introduce yourself and your team—it is important to take the time to introduce yourself and your associate researchers to the community so that everyone has some understanding of who is involved with the research program. A introductory photographic album that includes topics of interest, such as photographs of your family, friends, home, garden, and workplace, can be useful.

5. Have copies of your research proposal in the local language—as well as organizing meetings with the local people to explain what you are intending to do while in their area, written proposals allow for people to consider your proposal further after the meeting.

6. Develop a bilingual cooperative agreement/Memorandum of Understanding between yourself and your national counterparts. As part of this process, explain the project at a meeting with local community members. Ensure that women are also informed, either at these meeting or at separate ones, if that is culturally preferable.

7. Purchase additional sets of national and/or local maps to share with the community.

8. Donations and gifts—discuss with the community their needs to ascertain whether or not you can assist. It may be possible to assist a community obtain ↳ funding for a community-based activity. Present any donations in an informal ceremony to institutional representatives, along with an inventoried list of the donations which is signed by the recipients. Do not present donations to individuals. In developing communities, donations of medical supplies for local health clinics or educational supplies for local schools may be welcomed. However, be cautious about providing medical supplies that require greater skills to use than is available within the community.

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9. Recruit local community members as field assistants—without discrimination on basis of gender, age, marital status, religion, profession, level of formal education, political affiliation, or sexual orientation.

10. Take photos of community members and distribute them as soon as possible.

11. Translate research results into the local language—make photocopies and distribute widely within the community, inviting comment, and deposit a set of the data with the community.

12. Joint publication with local field assistants: the individuals who provide field assistance and knowledge are rarely included as co-authors of scientific publications. It is always important to consider the significance of their contribution, and to determine if they should be joint authors—or at least fully acknowledged within publications.

Notes

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