



EDUCATION MATERIAL



ON

HERBARIUM PREPARATION AND ITS MANAGEMENT



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1. INTRODUCTION

The UN Biodiversity Convention proposed at the Earth Summit in Rio de Janeiro in June 1992 highlights the growing and widespread interest in biodiversity. The vital role that herbarium plays in underpinning such projects is also becoming increasingly appreciated by a wider audience. The growing importance of herbarium and the information they contain cannot be over estimated. In order to meet future needs, therefore, it is essential that adequate human and financial resources are provided for their development and maintenance.

Three aspects of herbarium management deserve special attention:

- 1.1. The permanent preservation and management of collections and how this can be achieved at realistic cost.
- 1.2. Adding to the collections, it is important that herbaria are enriched with specimens of high quality and not filled with poorly collected and inadequately documented material.
- 1.3. Understanding how to extract, use and make widely available the data associated with the specimens. International databases are now becoming a reality, and it is therefore important that those involve with data capture are able to understand fully the significance of specimen labels and the information they contain.

2. DEFINITION OF HERBARIUM

The word Herbarium in its original sense referred to a book about medicinal plants. Tournefort (c. 1700) used the term for a collection of dried plants, this

uses was taken up by Linnaeus under whose influence it superseded earlier terms such as 'hortus siccus' (Stearn 1957). The herbarium can be defined as "the store house of preserved, dried and mounted plants built up over a long period of time and arranged according to scientific classification system".

3. PURPOSE OF HERBARIUM PREPARATION

- Store of reference material
- A means of identification
- An arbiter of correct names. Printed floras soon become out of date, and it is upto the herbarium to maintain nomenclature at standards.
- A comprehensive data-bank
- Serve the purpose of teaching
- For introduction in garden
- For hybridization work
- For research work
- For chemical collection
- Part for crude drug herbarium
- For ethnobotanical purpose
- For sale/ trade
- For biodiversity monitoring and bio-perspectives
- For floral mapping

- Help in development of computerized database of plants
- For identification of plant pathogenic and bio control fungi

4. TYPES OF HERBARIUM

Primarily, four main types of herbariums are categorized:

1. **General (or International) Herbaria:** These are very large herbarium with 4 million or more specimens and a global representation. Most general herbaria are founded early in the history of formal taxonomy and have grown to their present size over the years. The functions of general herbaria include:

- Broadscale studies of families and above
- Production of genetic monographs (with special attention to generic limits), major floras (covering several countries), national and local floras, check lists.
- Services include: Loans, providing facilities for visiting botanists, identification specimens (especially noting new taxa) and dispatching determination lists, distributing duplicates.

2. **National or Regional Herbaria:** Geographically these cover the country concerned and neighbouring or phytogeographically similar area. As far as possible, all taxa relevant to the area should be represented. The functions of national herbaria include:

- Contribution to major floras
- Production of national and local floras, check lists
- **Services include:** Loans, providing facilities for visiting botanists, identification specimens relevant to the country and dispatching determination lists, collecting material from the field and distribution

duplicates, providing material for ancillary disciplines (e.g. anatomy, cytology, chemistry) especially material freshly collected for the purpose.

3. **Local Herbaria:** These deals with a region within a country such as state, district or even a much smaller area such as game park or nature reserve. Local herbaria usually have a relatively short history and contain few (if any) type specimens. All taxa relevant to the area should be represented, but it is not necessary to keep large number of each taxon. The functions of a local herbarium include:

- Contributions to national floras
- Production of local floras and check lists
- Services include: Identifying specimens relevant to the area and compiling determination lists, collecting material from the field and distribution duplicates, collecting material from the field for ancillary disciplines (e.g. anatomy, cytology, chemistry) especially material freshly collected for the purpose.

4. **Special Herbaria:** These are often but not always small and have limited scope or a specific purpose, there are several types of special herbaria depending on functions:

- 4.1 **Historial Herbaria:** These may be kept as separate herbaria within a general herbarium (eg Wallich Herbarium at Kew or De Candolle Herbarium at Geneva) or belong to a separate institution (e.g. Linnean Society or universities, museums or monasteries). They are usually arranged in their original sequence and have restrictions governing consultations and loans. Because they are rich in type specimens the more important historical herbaria have been put on microfiche to help overcome the problem of accessibility.

- 4.2 Herbaria of Limited Scope:** These may be either limited taxonomically (e.g. cryptogamic herbaria, ethnobotanical herbaria, pathological herbaria) or ecologically (e.g. forest herbaria). Many herbarium in this category are of considerable size and importance and should be considered with national herbaria. These are often separately housed within general herbaria or other institutions such as universities or museums.
- 4.3 Teaching Herbaria:** These are housed in universities with more modest herbaria in colleges and schools. Teaching herbaria should contain specimens to illustrate morphological structures, the type plants representative of communities encountered in field studies, examples of both economic species and species of locally grown crops.
- 4.4 Job related Herbaria:** These could include collections of weed species for agriculturists or honey bee plants for bee keepers etc.
- 4.5 Herbaria for special research programme:** Voucher specimens for the following: anatomy, cytology, chemical studies, ecological surveys, host plants of insect and fungal pests, animal food plants etc. Voucher specimens are often housed in general or national herbaria, but they are frequently unwelcome as they can lack quality, are often of common taxa and take up valuable space. If housed in the university department sponsoring the research, the researcher has the convenience to direct access to the vouchers. However, a decision should be taken as to whether the collection is to be permanently or temporarily retained.

5. ABOUT THE HERBARIUM OF STATE FOREST RESEARCH INSTITUTE, JABALPUR

The State Forest Research Institute, as a part of conservation program, has a rich forest herbarium since its inception i.e. 1963. Over 20,000 plant specimens of 206

families, 1183 genera and 3457 species are harbored in the existing herbarium of SFRI. The modernization of existing herbarium adopting scientific norms and preparation of digital herbarium database using the recent advanced techniques in computer science and bio informatics were made. The outcome of the project using World Wide Web would offer a unique potential for dissemination of herbarium database throughout the world. The taxonomist around the world can share the information about herbarium specimens stored in a herbarium by considerably cutting down the cost and time. Attempts are being made on these lines.

6. GUIDELINES FOR PREPARATION OF HERBARIUM

6.1. BUILDING SPECIFICATION

- A herbarium building must enable the collection to be housed in dry, safe storage and facilitated a rational arrangement of the specimens.
- It should be fire proof and water proof.
- If a new herbarium is planned, allow for generous future expansion.
- If redeveloping and older building to house a herbarium, it may be necessary to construct intermediate floors to ensure that cabinets or box stacks are never too high.
- Certain functions should be carried out away from the main herbarium. If possible separate buildings should be provided or self contained areas isolated within the main building such as facilities for specimen reception and decontamination, poisoning room and drying facilities.
- Appropriate facilities for staff. Separate rooms in which food may be consume are also needed
- Ground floor reception area for visitors

- Work stations for staff and visitors.
- A mounting room
- A separate room for spirit (wet) collections.
- A library, or provision for essential literature
- The ideal condition for paper conservation are 22°-23°C at ± 55% humidity.
- Adequate ventilation is essential and it is important to aim for the renewal of air.
- To prevent the entry of insect pest, windows and external doors should be fitted with draught excluders and with insect proof screens.
- It is important to ensure adequate lighting and sufficient powerpoints to accommodate electric equipments, computers etc.
- Floor surfaces should be easily cleaned and maintained, but not slippery. Fitted tiles or wood blocks are better.
- The best boxes to kept herbarium specimen are made from cloth-covered hardboard and are specially constructed to have a drop-flap front with a label-holding slot as well as a lid-top. The metal boxes which are more insect proof can also be adopted.
- Metal cabinets are more insect proof and may be a deciding point in tropical herbaria. Cabinets made of certain tropical woods (e.g. *Cedrela odorata*) may stain specimens. Cabinets should preferably have shelves which are atleast 2 cm deeper and wider than the herbarium sheets, and approximately 15 cm apart. The doors of the cabinet should be close

fittings with a dust proofing strip of, for example rubber or felt, and the catches should fasten tightly. These points are important for exclusion of insect pest.

- A programme for routine maintenance may be necessary to ensure a continuing good fit of cabinet doors. Herbarium cabinets may incorporate a slot on the inside of the door to contain insect repellent or insecticidal substances.
- Where space is limited, the cabinets or shelves which carry boxes can be installed as mobile storage unit.
- All rooms, corridors and stairways must be separated by adequate fire doors and regularly maintain fire extinguishers must be placed in all area of the building.

6.2. PLANNING FOR COLLECTION OF SPECIMENS

Adequate planning should be undertaken for collection of specimens. Poor planning produces poor performance. The nature of planning should consider following points:

- Nature of field work
- Purpose of collection
- Adequate duration for collection according to size of area.
- Bring Map of the area selected for collection.
- Know about the weather conditions and hazardous wild animals, pests etc., as they may be injurious or may kill the collectors.

- A local guide must accompany the collectors.
- Don't collect any specimens threat to extinction.

What and how to collect

- Representative of the population
- Show range of varieties of individuals
- Collect samples of undamaged/ fresh parts of leaves, stem, flowers and fruits. Look out for heterophylly.
- Atleast 6 specimens of each plants need to be collected for conservation, research, detailed study, and exchange to other herbaria. However, it depends on the object and type of herbarium.
- A field book having details like collection number, name of collector, locality, habit, habitat, distribution, flowering, fruiting, local name, scientific name, family, description, local uses etc., must be kept during collection.
- Collection should be made in a systematic way to cover the whole area.

6.3. DISINFECTION AND PRESERVATION

- After collection, the specimens should be pests in blotter sheets for 3-4 times to ensure removal of moisture from the specimen and to avoid moulds and insects.
- After blotting, the specimens must be disinfected using mercuric chloride solution (0.1%) or Lauryl pentachlorophenate (LPCP) to kill the inoculums of pathogens and to make specimens unpalatable to insects and mites. LPCP is used in solution: 3.75% in white spirit, in 5% Varsol. The LPCP is

generally said to be safe as compared to mercuric chloride. Deep freezing is also undertaken for contamination. Gama radiation is increasingly used to sterile food and medicinal items and may have potential for pest control in herbaria. Microwave ovens can also be used for small quantities of materials. Microwaving can have deleterious effects on specimens: the viability of seeds and spores will be greatly reduced, pine cones can open, fruits such as nuts can explode, cell structure in fungi may be affected, surface waxes may be destroyed, slight changes may be made to the surface of trichomes and it is possible that there may be effects on macromolecular chemistry. These points must be considered for specimens to be selected for processing under microwave.

- After poisoning, the dried specimens are mounted on mounting sheets

6.4. MOUNTING OF TERRISTRIAL SPECIMENS

- Mounting is done to support the specimen as a permanent record in the herbarium.
- The mounting sheet should be made from white or cream cartridge type paper. The poor quality paper will deteriorate and remounting will become necessary.
- Size of mounting sheet: The following sizes are most frequently used: 42 x 29 cm mostly in USA, 42 x 26 cm in Kew, and certain other European herbaria, some herbaria use larger sizes e.g. Natural History Museum 44x 29 cm. For economic regions consider A3 size if you are starting a new herbarium, but the most important governing factor will be the cabinet size. A few extra large specimens may require 'palm sized' sheets, normally twice the standard size.

- Species cover to protect specimens of same species should be acid free, light weight, but tuff paper with the grains running parallel with the fold should be used.
- Paper capsules or envelops are also used to protect small portion/ part of the specimen along with the mountain sheets.
- The adhesive used for mounting must be neutral or slightly alkaline, extremely long lasting.
- The tapes used for strapping the specimen to sheet are generally linen tape as used by book binders, polyester tape etc.
- To attach entire or parts of specimen to mounting sheet, especially to reinforce the mounting of bulky parts of specimens such as twigs and larger fruits, thread of variable sizes should be used.
- The label is one of the most important part of a herbarium specimen. It should be printed to include following items: Herbarium name, scientific name, vernacular name, collector's name and collection number, date of collection, collection locality preferably with latitude and longitude coordinates, habitat/ ecological notes including altitude if, available, supplementary data including habit of the plant, flower colour and any other feature which may be important for identification, but cannot be seen directly from the specimen and uses.
- If the specimen is of poor quality or sterile, consider whether it should be kept or discarded. There can be good reasons for keeping sterile specimens, before any are discarded consider the following:
 - In many species flowers and leaves do not appear together in the

same season. This often happens in woody plants, but also in herbaceous taxa such as *Equisetum*, some *Orchids* and many other Monocots.

- Coppice or sucker shoots frequently have foliage a typical of the species. The collection may have been made to demonstrate such variation.
- Some sterile collections may have been made as they are known to be the only record of the taxon for the area concerned.
- **Check list of mounting material:** Cartridge paper or white board, approved adhesive for applying labels and specimens, paper capsules, translucent or transparent packets, paper clips, linen or cotton thread, gummed paper for backing stitches, gummed linen tape for strapping, fine translucent paper, waxed paper, drying paper, transparent polyester sleeves, slightly larger than the sheets.
- The main aims of the mounting process are : 1. To display the specimen and data to allow maximum observation/ laying out, 2. To preserve the specimen by securely attaching it to strong mounting paper or card, but at the same time allowing for removal of small portions for more detailed study.
- The position of the main label should be easier to read when kept in genus covers which open on the right. Additional labels should be placed above the main label or atleast close to it. Ideally a space should be left above the label to allow for future attachment of determination slips.
- Choose the best side of the specimen to display as many features as possible.

- Expose hidden flowers or fruits by removing leaves and placing into paper capsule, together with any other loose items.
- Display both sides of leaves - if necessary, detach and turn one leaf or place in capsule.
- If only one larger leaf, cut off part and turn or place in capsule.
- When mounting more than one plant on a sheet: 1. Keep them all aligned the right way up, 2. Place the largest or heaviest specimens at the bottom to prevent the sheet from bending when handled.
- Tiny plants: If numerous, spread out a few but place the majority in a capsule, if only a few keep all in the capsule.
- Many larger specimen are best arranged diagonally.
- Overlong specimens can be folded to fit the sheet so that the apex points upwards or the base downwards.
- If a specimen has only one larger flower, this should not be stuck down. However, it must be protected by placing a window of translucent paper over it. This window is then secured by its outer edge only, allowing it to be folded back for close examination of the flower and its point of attachment to the specimen, information which is lost, if the flower is detached.
- There are two main ways of mounting specimens: *strapping* (the straps may be either thread, linen tape, archival self-adhesive tape) or plastic glue and *overall gluing*. Strapping is perhaps appropriate for small herbaria with restricted access to visitors, while overall gluing can give

better long-term protection to specimens in large, busy herbaria with free access to visitors and frequent requests for loans.

6.5. MOUNTING OF AQUATIC PLANTS

The specimen is likely to take up the water from the water based glue and become distorted, unmanageable and difficult to mount. For this reason, latex glue has been used for mounting delicate aquatic angiosperms.

The following method should be adopted:

1. Carefully arrange the specimen on a mounting sheet.
2. Cover with a sheet of waxed paper.
3. Without disturbing the specimen turn the sheet + specimen + waxed paper over as a block so that the waxed paper is now at the bottom.
4. Remove mounting sheet, and apply glue to the area which will cover the specimen.
5. Replace mounting sheet glued side down.
6. Invert the stack again.
7. Rub down the specimen through the waxed paper in order to ensure that the specimen is in contact with glue. Remove the waxed paper carefully. Some parts may need extra gluing.

The finished sheets can be stacked with waxed paper, drying sheets and sandbags as described above.

Attaching labels and paper capsules

- The labels and paper capsules can be attached with the same glue as the specimen.

- Some labels especially if made from paper with a grain, tend to expand as they absorb moisture from the glue and can, if not handled carefully, wrinkled.

7. CONSERVATION AND MANAGEMENT OF HERBARIUM

- Cleanliness and tidiness of herbarium specimens is desirable.
- If the herbarium building is not air-conditioned and the cabinet doors not air tight the specimens will become dusty. The sheet should be dusted with soft haired brush (a thick water colour brush or camel hair brush) to remove loose particles. If the leaves and the stems of the specimens are robust they can be similarly treated, but flowers and other delicate structure must be avoided for fear of damage.
- Any remaining dust on the sheet can be removed with the help of slightly adhesive substance such as "Blue tack", a putty rubber or a special archival product i.e. "Absorene".
- Stains on herbarium sheets caused by the application of liquid insecticides are best ignored.
- Fragile labels can be replaced with newly copied version, but the original must be preserved in a paper capsule mounted on the sheets. The outside should be annotated "Original data label".
- Place paper strip or tape along the damaged edge so that it projects slightly beyond the sheets.
- In case of short tears extending upto 7cm into the sheet, glue paper strip to underside of sheet along the length of tear should be provided.

- Original mounting sheet should be protected covers and supported by re-backing sheets.
- In case of remounting of specimen is essential, first draw and outline in pencil, then cut away as much as possible of the old sheet from around the specimen with the help of artist's cutting knife or scalpel cut. The specimen with its paper backing can then be glued to a new mounting sheet, using the approved mounting adhesive, covered with waxed paper and placed under a sandbag until dry. The greatly reduced area of the old mounting sheets now backed will reduce acid migration.
- Insect repellants such as naphthalene or paradichlorobenzene (PDB) are sometimes placed in small quantities in herbarium cabinets. Do not use both naphthalene and paradichlorobenzene (PDB) together in warm climates because an oily mess can result. It is also suggested that essential oils such as lavender, applied on wads of cotton wools could be used as insect repellent.
- Spraying or painting of mercuric chloride or LPCV (Lauryl Panta Chloro Phenate) on regular basis should be done on mounted specimens after the rains each year.
- Database should be developed with the help of MS Access Software and by procurement of other required softwares developed for herbarium management and taxonomy of biodiversity. The information will be made available in CD- ROM as well as on website for general use of public and scientific communities of the world.

8. SALIENT FEATURES OF PREPARED SOFTWARE FOR DIGITAL HERBARIUM DATA BASE

The available information including label information of herbarium sheets as well as secondary information pertaining to collection number, habit, habitat, local name, botanical name, family, distribution, taxonomical features, flowering and fruiting period, uses were installed in the software. The Software development for digital herbarium database and plant identification has following features viz., Stand along with front end (visual basic. net), back end (MS access) and external tool (crystal report). Easy to handle (user friendly graphic user interface GUIs). Software must be password protected. Every genus and species has unique ID. Grouping of genus and species. Main menu: the key characters for identification of trees, shrubs, climbers, herbs, etc had arranged in the main menu under different icons such as Bole (Buttressed, aerial/still roots, prickled, thorny), Stem character, (stem type, stem surface, stem modification, such as above ground and underground, modification type), Bark features (color, texture, Blaze color, exudation and its color), Leaf type, Leaf form, Leaf size, Leaf margin, Leaf base, Leaf Apex, Petiole, Petiole length, Leaf arrangement, Stipules, Nerves, Position of the glands, Phenology (flower, fruit characters and seeding periods), Inflorescence character (type and color of inflorescence), flower character such as epicalyx (type, number, colour, arrangement). Flower characters - Calyx (calyx forms, calyx type, calyx surface, color, number of sepals and special characters, if any), corolla (Corolla forms, corolla surface, corolla color, number of petals and special characters if any), perianth (shape, type, color, number of lobes), stamen (number of stamens, stamen forms, stamen arrangement, stamen dehiscence, stamen color and any special character), staminodes, stigma (stigma, style present / absent, placentation, ovary position, number of ovules, number of locules), fruit characters (type, color etc), seeds characters (type, color etc), stipules (type, number, color, special

character, if any), gland (type, color, position, special characters, if any), bracts (type and no of bracts, special new bract option) and bracteoles (present/absent, number of bracteoles), spine (type, modification), tendril (type, modification), phonological characters (flowering, fruiting and seeding period) etc. The herbarium sheet icon covers Location, Habit, Habitat, Distribution, English name, Local name, Genus Name, Species and Synonymous name, Sub species/ variety, Family, Collection number, Collector's name, Collection date, Uses / ethnomedicinal value, Images of herbarium sheets: Minimum five photographs of each species of one locality, Images of live specimens, Others: The flora information system has inbuilt taxonomical data for identification of plants.

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