**HERBARIUM SHEET**

**INTRODUCTION:**

A herbarium (plural herbaria) is a storehouse of dried plant specimens collected from far and wide, mounted on appropriate sheets, arranged according to some known system of classification and kept in pigeonholes of steel or wooden cup-boards and are generally associated with botanic gardens and educational or research organizations. The word "Herbarium"was derived from Herbar means plant specimens and arium means an artificial place.

Tournefort (1700) used the term Herbarium as an equivalent to Hortus siccus and Linnaeus also used this term. It was mainly through Linnaean‟s influence the word Herbarium superseded the former term Hortus siccus, in Latin literally meaning dry garden. Lawrence (1951) defines it, as “the arrangement of specimens in the sequence of an accepted classification and the specimens are available for reference or other scientific studies. “

Herbarium” used in its original sense referred not to a collection of plants, but to a book about medicinal plants. According to Fosberg and Sachet (1965), a modern herbarium is “a great filing system for information about plants, both primarily in the form of actual specimens and secondary in the form of published information, pictures and recorded notes”.

**HISTORY OF HERBARIUM:**

 Luca Ghini (1556) is the sole initiator of the art of herbarium making, who started collecting, drying and pasting them over paper.

Gherardas Cibo, student of Ghini began collecting plants and preserving them from 1582 and continued till his death.

 In those days, the herbarium sheets were bound into volumes and just like books these herbaria volumes were also arranged vertically as in Libraries.

 However, in 18th Century, Linneaus started a new method in which he mounted his specimens on single sheets and started storing them flat horizontally, which is followed by almost all the museums and herbaria in the world.

**OBJECTIVES OF HERBARIUM:**

i) To provide facilities for determination of any material including new taxa.

ii) To enable preparation of new monographs and floras.

iii) To preserve specimens of historic importance.

iv) To assemble data for working out ranges and ecological distribution.

v) To bring together in a relatively permanent form of specimens for comparative morphological or phylogenetic studies.

vi) To provide material for specific research as in plant anatomy, palynology and ethnobotany and also for molecular research.

**HERBARIUM SHEET:**

The general size of the mounting board or herbarium sheet is 42 x 28 cm. The label with the size of 12 x 8 cm is generally pasted on the bottom right hand corner of the mounting board. The specimen is pasted as far as possible in the middle, field number at middle of left margin and accession number and/or barcode at right top of the herbarium sheet.

**ROLE OF HERBARIUM IN TEACHING AND RESEARCH:**

***Teaching:***

The herbarium serves as an aid in teaching botany to degree and post- graduate students. It is difficult for any student to identify local plants without the help of a proper herbarium. Many specimens, which the teacher would like to show to his students, may not be available fresh at the time of giving the course. In such situations, available specimens in the herbarium serve the purpose.

***Research:***

Herbarium, which was considered to be the concern and tool of an “orthodox taxonomist” is totally unanimously believed to be an essential requirement for biosystematic research. For biosystematic studies (including population studies) the worker needs material of his taxon from far and wide. As it is not conveniently possible always to visit different areas of occurrence of the taxon, one has to largely fall back on resources of the herbaria.

For ethnobotanical researches, the herbaria have proved to be very valuable source of information. Many native uses of plants recorded on the herbarium sheets have never gone into published literature and therefore have never been subjected to scientific scrutiny.

**FUNCTIONS OF HERBARIUM:**

A modern herbarium serves numerous valuable functions. Some of the important functions of herbaria are as follows:

(a) A herbarium serves as an invaluable conservatory of plant material of flora. collected from different parts of the world. Thus, they provide at one place, basic material for study of flora and vegetation of different places or regions.

Since it serves as a permanent record of flora of those regions, collections in the herbarium provide evidence of the vegetation of a region, which may be destroyed due to some natural catastrophes.

(b) The specimens in the herbarium carry valuable data on their labels. These include data on habitat, habit, local names, colour of flowers or other characters of the plant, native uses of the plant, abundance or frequency of the species, associated plants, etc.

Such data provides valuable material for proper morphological description and range of variation of a similar plant collected from a different region, range of distribution and variation in its uses in different places. Thus, a herbaria provide data for botanical, ethno-botanical and phytogeographical studies.

(c) The herbarium serves as an aid in teaching botany to students in institutions where a herbarium is present, as it helps a teacher to show his students a plant specimen which may not be available fresh at the time of giving the course. It also helps students to identify local plants collected by them.

(d) Preserved specimens of herbaria are used in almost all types of taxonomic research. It is believed to be an essential requirement for biosystematics research today, for correct identification and nomenclature of the plant under study.

(e) The specimens in the herbaria are very often used as a source of material for anatomical, palynological and chemo-taxonomical studies.

(f) The herbaria provide important data on actual places of occurrence, time of flowering and fruiting, associated species and other data for researches in embryology, cytology and ecology.

(g) The herbaria have proved to be very valuable source of information for ethno-botanical researches as many native uses of plants are recorded on the herbarium sheets.

**MAJOR HERBARIA IN INDIA:**

1. The Central National Herbarium (CAL) located at Howrah, established in 1795 and comprises about 2,000,000 (2 million) specimens. This is the first herbarium in the country and one of the most important Asian Herbaria.

2. Forest Research Institute, Dehra Dun contains 350,000 specimens (DD)

3. The National Botanic Gardens, Lucknow contains 260,000 specimens (LWG)

4. Blatter Herbarium, St. Xavier‟s college, Fort Bombay contains 200,000 specimens. (BLAT)

5. Botanical Survey of India has herbaria attached to their regional centres and units in different parts of India.

**COLLECTION:**

There are three ways of collecting the plant specimens in the field.

1. If the trip is for one day, one can carry the plant press and newspapers or blotters. The

specimens are pressed then and there in the field.

2. The second method is to keep the collected specimens in metal can called Vasculum.

Wet newspapers must be placed inside the Vasculum to keep the specimens cool. The plants kept in the Vasculum must be transferred to newspaper that day itself or the Vasculum along with the plants may be kept in a cool place overnight.

3. Now-a-days polythene bags are available and they are of varying sizes. The collected plants are placed inside and the mouth is tied tightly. This is easy to carry and there will be no serious loss of the plant material kept inside. The plants can be pressed after reaching the headquarters.

**FIELD NOTE BOOK (FIELD DIARY):**

While preparing herbarium specimens close attention should be given to recording all necessary data concerned with the plants, which may not be present or detected after drying. The following points to be noted during plant collection in field notebook:

1. Colouration of foliage and floral parts.

2. Corolla venation.

3. Anther colouration before and after dehiscence.

4. Viscidity of parts.

5. Pollinating agencies.

6. Texture of foliage and perianth parts.

7. Colour and nature of fleshy matured fruit.

8. Habitat.

9. Exact location; use proximate object near the site.

10. Waxed pattern of shoot and root system.

11. Insecticides and repellents.

12. Branching pattern of shoot and root system.

13. Type of soil, moisture content, slope and light conditions.

**Herbarium collection and design:**

Botanical traditions vary between countries and botanical schools. Here I will describe the way plant collection is typically done in countries with German botanical tradition, e.g., in Russia and Ukraine. I believe that this way has some advantages over the typical American way, and deserves a further expansion.

**1. How to collect plants:**

Now to the collection process. Choose the healthy, average plant with both vegetative and reproductive organs available. The selected plant (if it is not a vine, like morning-glory, or big woody plant) should be taken out with roots. This is especially important if you collect grasses or sedges where one of the most significant determination characters is the way of vegetative reproduction (intravaginal or extravaginal), which is visible only on underground parts. Species of dock differ by the presence of taproot, and there are many more species where identification requires underground parts. If you collect a really rare plant, you may leave underground parts in the soil to give it the chance to reproduce.

Immediately after digging out the plant, you need to untie the field press, take the topmost (one of field press sides, side with handling strap must always be upper!) collection sheet, open it and place the plant on its half.

The next step is to straighten the plant (this is not a final straightening but still very important one). The goal is to convert 3D real-world plants into 2D herbarium samples. You will need to make all the important parts as much exposed as possible.

You should press most of the plant surface to the paper, making it flat. To hold parts flat, you can use various hard and heavy things like stones, coins, trowel, etc., and finally, your own fingers. If there is a place where leaves and/or other organs (like flowers) will overlap (please try to avoid overlapping), you should put there the small piece of paper. Otherwise, these contact places will turn black during the drying process. Some (2–3) leaves good to place reversely, the backside up.

Flowers should be thoroughly straightened to show all its primary organs—calyx, corolla, stamens, and pistil. If petals are fused, do not straighten them. Be very careful with the delicate flowers of some plants (like flax or evening primrose). It is better not to touch them with hands but use preparation needle instead. To dry these flowers thoroughly, I recommend to place them between two sheets of thin paper (or within one bent paper piece) and put the piece of cotton wool above. You can do the same with other complicated parts. Do not touch this flower paper until the plant is completely dry!

After straightening, slowly close the collection sheet from left to right (do not forget to remove everything which was used for holding). While holding the whole pile, take empty collection sheet from bottom of the pile and place it above the sheet, which was just used.

**Long plants** like vines, shrubs, and trees are collected in parts, typically branches with leaves and reproductive organs. Note that since it is impossible to estimate the size of such a plant from what was collected, the collector must note the height (or length for vines) on the label.

**Big herbaceous plants or plant parts.** If the plant does not fit after bending from above, bend in from below. If it still does not fit, continue bending up to 5–6 times (especially if plants are narrow, like rushes and sedges). Otherwise, you might apply more damaging procedures—cut the plant in a few parts, discard what is not too valuable (typically, the middle) and keep others. Sometimes, you need to place a disintegrated plant on several collection sheets (do not forget to mention it on labels). This is how they collect palms.

**Ferns** are collected as a whole, but if the plant is too big, it will be enough to keep the half of the rhizome (cut it lengthwise) and 1–2 whole leaves (fronds), preferable with sporangia.

**Spikemosses and other creeping plants** might also be collected in parts. It is enough to keep one segment with roots, leaves, and spikes or flowers.

**Water plants** are better to expand in water, on a sheet of dense white paper (like the paper used for mounting, see below) with preparation needle. This is the typical way to collect duckweeds and other plants floating in water. The thick paper sheet with the self-adherent plant is then placed inside of collection sheet.

**Plant parasites** should be collected with a host. Sometimes, non-green parasites will change color significantly after drying so it is better to note the color on the label. The same is recommended for plants changing colors of their flowers.

**Juicy plants,** cacti, plants with thick roots and stems need special treatment. Sometimes, it is enough to cut out lengthwise (with sharp knife) part of the leaf, stem, or root. Sometimes, it is better to leave only skin. In extreme cases, you will need to boil the juicy part in water or even in ethanol (however, remember that the last procedure will reduce the possibility of DNA extraction from the sample).

**Small plants,** when every plant is significantly smaller than the collection sheet, it is better to collect in larger quantities, to fill the sheet with plants. Do not do it for rare plants, though.

In all, the most important on this step is to keep all significant morphological characters in place.

**Do not forget to write the draft label and attach it to the sheet!**

**2.Drying:**

If the weather is dry and sunny, presses are better to keep outside. Wind will make the drying process even better. If the weather is not so good, it is better to dry in-doors. Do not apply any heating tools without careful thinking because the quality of herbarium suffers from overheating. If you must, apply heating not more than 20–30 min per hour, and turn your press every 10–15 min.

**3. Labeling:**

Your excellent herbarium sample will drop 99% of its scientific value if the label is lost. On the contrary, poorly collected sample with the label is sometimes of immense value. This is why you should remember about the label from the first collection steps.

From the time of field press to the end of drying, each sample must have a draft label.

Sticky paper is especially good for draft labeling. There are many ways of labeling, but the bare minimum is:

1. location ID which in turn corresponds with

(a) GPS coordinates

(b) date of collection

(c) names of collectors;

2. number of sample (sample ID) within location;

3. and some ecological remark. Please do not overlook this last label as the sim-

ple phrase like “in prairie” or “lakeshore” may tell important information to future researchers.

There also might be a place for some additional information like

4. number of associated photograph, this is especially handy if this photograph

is the image file electronically supplied with GPS coordinates;

5. size—for trees, shrubs and all other plants which are collecting in parts;

6. and other morphological remarks like flower color, plant color, etc.

When you finish drying, you will need a new label. This is a small (8 × 11 cm) piece of paper.

1. Latin name of the plant (optional)

2. Geography of collection which must be enough to find this collection place again (GPS coordinates are preferred)

3. Ecological remark: type of forest, host for the parasite, the orientation of slope, etc.

4. Date of collection

5. Name(s) of collector(s). This might be needed for future inquires.

6. Name(s) of who performed plant determination (optional)

When mounting, this label goes to the bottom right corner.