COURSE NAME-GYMNOSPERMS, TAXONOMY OF ANGIOSPERMS AND ANATOMY
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UNIT-14 Herbarium Methodology and Herbaria

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HERBARIUM

A Herbarium is defined as a collection of plants that usually have been dried, pressed, preserved on sheets and arranged according to any accepted system of classification for future reference and study.

Herbarium is a store house plants specimens where plant specimens are collected from far and wide preserved in dried condition mounted on a standard size of herbarium sheet. The standard herbarium sheets are kept in pigeon holes under separate generic cover and arranged according to any accepted system of classification for future reference and study. It is a great filing system for information about plants primarily in the form of actual specimens and secondarily in the form of recorded notes on labels attached on the sheets. The material in the herbarium remains as permanent record of flora of those regions even the natural topography and the vegetation have changed or extinct. The herbarium specimens bear labels with adequate data on habitat, common name, native place, uses, ecological notes like abundance frequency rarity of species, associated plants, habit *etc.* A herbarium receives fresh material by collection of its staff, taxonomist, explorer, gifted by other taxonomist, exchanges *etc.* So it is a conservatory of material along data.

HISTORY

- The art of Herbarium was initiated by an Italian taxonomist Luca Ghini (1490-1556). The concept of preserving plant specimens in dried form is 450 years old. The oldest preserved herbarium specimen is kept in Rome, collected by the naturalist Gherardo Cibo a pupil of Luca Ghini (1532).
- Luca Ghini made many plant collecting journeys in Italy. The plants were presented in this way by him and the first herbarium of the world was established in 1545 in University of Padua, Italy. The first Botanic Garden was also established in the same year.
- The word ‘Herbarium’ was originally applied not to collection of plants but to a book dealing with medicinal herbs. Tourneforte (1700) used two terms as an equivalent to Hortus siccus, which was later on adopted by Linnaeus.
- In the earlier times the specimens were mounted on sheets and bound in the form of book. It was continued till the time of Linnaeus. Today the plants are mounted on single sheet and arranged according to classification. The present concept of herbarium collection alongside detailed field data is also due to the experience of botanists over four centuries.

KINDS OF HERBARIA

The kinds of herbaria depend upon the contents, purpose, region/place, plant groups *etc*. There are different kinds of herbaria depending upon the type of holder (Government organizations, individuals, institutional, universities *etc*.), interest, particular plant type (fungi, algae, angiosperm, herb, medicinal, woody *etc.)* and uses (medicinal plants, crops, cultivated plants) *etc*. like following:

(i) Herbaria of Organizations e.g. Herbarium of National Botanical Research Institute (NBRI), Lucknow, Herbaria of Botanical Survey of India (BSI) *etc*.

(ii) Regional Herbaria *e.g*. Herbaria of regional circles of BSI (Botanical Survey of India)

(iii) Local Herbaria.

(iv) Herbaria of institutions, universities, colleges *etc*.

(v) Herbaria of medicinal and aromatic plants.

(vi) Herbaria of crop cultivated plants.

(vii) Herbaria of weed flora *etc*.

Table I

	Herbarium	No. of specimen (approx.)
1.	Museum National d' Historia naturelle, Paris	10,500,000
2.	Royal Botanic Garden, Kew	>5,000,000
3.	Komarov Botanical Institute Leningrad	>5,000,000
4.	Conservatoire et Jardin Botaniques, Geneva	5,000,000
5.	New York Botanical Garden, New York	4,300,000
6.	Harvard University, Cambridge, USA	4,250,000
7.	U.S. National Herbarium, Washington DC	4,110,000
8.	British Museum (Natural History), London	4,000,000
9.	Institute de Botanique, Mont pellier	4,000,000
10.	Naturhistoriske Riksmuseet, Stockholm	4,000,000
11.	Royal Botanic Garden, Edinburgh	2,350,000
12.	Gray Herbarium, Harvard University, Cambridge USA	1,485,000
13.	Botanical Research Institute of Texas, Texas (1985)	500,000
14.	University of Minnesote Herbarium, Venezuele (1992)	830,000
15.	Washington State University-Marion Ownbey Herbarium, Marion (1995)	350,000

Table II
Some Important Herbaria of India

	Name of Herbarium	No. of species (approx.)
1.	Central National Herbarium, Sibpur Howarh	2,50,000
2.	Forest Research Institute, Herbarium Dehradun	3,00,000
3.	Botanical Survey of India, South circle Coimbatore	20,000
4.	Botanical Survey of India, Western circle Poona	12,500
5.	National Botanic Garden, Herbarium, Lucknow	1,00,000
6.	Botanical Survey of India Eastern circle Shillong	1,00,000
7.	Botanical Survey of India, Northern circle Dehradun	60,000
8.	Botanical Survey of India, central circle Allahabad	40,000

Minor Herbaria of India

(1) Botanical survey of India, Andaman and Nicobar circle, Port Blair.
(2) Botanical survey of India, Arid zone circle, Jodhpur.
(3) Botanical survey of India, Sikkim Himalayan circle, Gangtok, Sikkim.
(4) Delhi University Herbarium, Delhi.
(5) Llyod Botanic Garden, Darjeeling.
(6) School of Plant Morphology, Meerut College Meerut.
(It contains approximately 25,000 specimens).

FUNCTIONS OF HERBARIUM

The aim of the herbarium is to accumulate all possible information about the all the plants with which it may be concern like habit, habitat, phenology, distribution, ecology and uses in one place. A herbarium may be concerned with a specific area, such as a township, commissionery, district, state, country, or it may attempt to cover a nation, a continent. It may attempt to accumulate all information available about a single taxon, such as a species, or about a few taxa, such as those included in a genus or a family, or it may attempt to contain information about all kinds of plants.

The classification of the world flora is primarily based on herbarium material observation and associated information. More recently, the herbaria have gained importance for sources of information on native, endemic, rare and endangered species and are of primary interest to conservation groups.

A herbarium serves valuable functions or utility in various forms as follows:

1. Repository of plant specimens: the first and most important function of a herbarium is to store dried plant specimens and provide safeguard these against destruction, loss and make them ready for study.

2. **Safe custody of type specimens:** Type specimens are those specimens in which name of taxa is based thus these are proof material for identification, correct naming and principal proof of the existence of a species or an intra-specific taxon. These are kept in safe custody, often in rooms with restricted access, in several recognized herbaria.
3. **Identification of specimens:** The majority of herbaria have a wide-range collection of plant specimens and offer facilities for identification at same place and same time. Researchers can personally identify their collected specimens by comparison with the duly identified herbarium specimens.
4. **Resources for compilation of Floras, Manuals and Monographs:** Herbarium specimens are the 'original documents' along with necessary information, upon which the knowledge of taxonomy, evolution and plant distribution rests. Floras, manuals and monographs are largely based on herbarium resources.
5. **Facilitation centre for taxonomic training and herbarium methods:** Many herbaria carry facilities for training young taxonomist, botanists, graduates and undergraduate students in identification, classification, herbarium practices, organizing field trips and even expeditions to remote areas.

6. **Information on geographical distribution:** Major herbaria have collections from different geographical areas of world along with their details, thus, scrutiny of the herbarium specimens can provide information of geographical distribution and range of distribution.
7. **Preservation of voucher specimens:** Voucher specimens are specimens collected by botanist, researcher and naturalist on which any specialized study has been undertaken. These are later preserved in various herbaria provide material for further future study.
8. **Provide Material for teaching and research:** Herbarium acts as teaching aid in botany to graduate and post-graduate students. While teaching a teacher can show herbarium specimens if fresh material is not available at the time of giving the course. It is of essential requirement for biosystematic research *i.e.*, for correct identification and nomenclature besides a source of material. It provides research material for anatomical, palynological and chemotaxonomical studies.

MAKING OF HERBARIUM

Herbarium preparation is an art rather than a science; it requires skill, dedication, discipline, enthusiasm and love to plant and nature. Before making a herbarium first question in mind, what to collect, how to collect and where to collect.

Thus plant collection and specimen preparation is first step of herbarium preparation and requires some special materials and instruments. The materials and instruments required for plant collection are:

- Vasculum: vasculum for keeping the collected plants and their twigs.
- Plant press.
- Digger/Khurpi: for digging up roots and underground parts.
- Knife: For cutting.
- Secateurs (Plant cutter): A pair of secateurs for cutting woody twigs.
- Leather/rubber gloves.
- A pocket lens/magnifying glass.
- Digital camera.
- Forceps.
- Blotters or newspaper

- Corrugated plates.
- Collection bags/Plastic (poly) bags.
- First aid box,
- Topographic maps,
- Compass.
- Global Positioning System (GPS)
- Field book
- Note book, pencil, pens *etc*.

A vasculum

Plant press

Pocket Lens

Knife

Khurpi

Secateurs

Herbarium Technique

The herbarium technique or specimen preparation involves following steps:

- Collection
- Pressing
- Drying
- Poisoning
- Mounting and stitching
- Labeling and
- Deposition

1. Collection:

First step of herbarium preparation is collection. A herbarium specimen to be collected should be complete as possible and represent whole plant. Herbs and small shrubs up to 2-3 ft. tall should be collected in flowering condition, along with leaves and roots.. There are, in general, two techniques of collecting specimens: (i) by use of vasculum, the other uses the so-called field press. Now a day's it is in culture use of polyethylene bags as a substitute for a vasculum. (ii) Field press consists of two lightweight press frames, hinged along one side with two short straps and the straps around the body of the press to keeps it closed and apply pressure on specimens thus specimen becomes flattened.

2. Pressing

Each specimen should be composed of material to fit within the dimensions of a standard herbarium sheet (29 x 42cms). When collecting small herbs, several should be collected, so as to fill a folded sheet of newspaper, and later a standard herbarium sheet. The specimens should be placed in the field press at the first opportunity, either directly after collection, or sometimes after a temporary storage in vasculum or a polythene bag. The bulky fruits may be thinly sliced with the help of sharp knife and then pressed. Some special groups of plants such as conifers, aquatic plants, succulents and mucilaginous plants causes problems during collection and need special methods for their pressing.

3. Drying:

For drying specimens two methods are used:

3.1 Natural Drying

Drying of pressed plant specimens is a slow process and it is time consuming and tedious especially in humid and rainy areas. Generally specimens dried naturally by changing blotting paper continuously but in some cases artificial heat may also be used. Drying may take up to weeks or month for complete drying.

The plants, freshly collected, are placed in a press without corrugated sheets and the press is locked for 4 hours. The change of blotters or newspaper sheets is repeated every 4-8 hours initially and few days later, increasing the interval between the changes successively until the specimens are fully dried. The whole process of drying may take about 10 days to one month, depending on the specimens and the climate of the area. All these blotters/newspaper are placed between two wooden frames of plant press and pressed tightly together by two straps.

3.2 Drying With Artificial Heat:

Drying with the help of artificial heat takes 12 hours to two days. The specimens, after the initial sweating period in the field press, are transferred to a drying press. The press is kept in a drier, a cabinet in which a heat lamp, dry hot air blower or electric bulb warms the air, drying the specimens by movement through corrugates. The rapid drying of specimens using artificial heat has limitations of rendering plants brittle, loss of loom and some colour change in leaves.

4. Poisoning:

The specimens need poisoning to keep away insects, paper borer, silver fish and fungus attack. This is normally done when the specimens are partially dehydrated or dried. There are several methods of treating specimens making them either permanently poisonous or unpalatable to herbarium pests. Specimens may be poisoned by dipping or painting them with an alcoholic solution of mercuric chloride ($HgCl_2$). Another method employs lauryl pentachlorphenate (a 3.75% solution of LPCP in pure white kerosene free from high boiling paraffins).

5. Mounting and Stitching:

The dried specimens are mounted on herbarium sheets of standard size (42 x 29 cm). Mounting is done with the help of Saresh glue, fevicol, fixatives, adhesive or cello-tape. The bulky plant parts like dry fruits seeds, cones *etc*. are dried without pressing and are put in small envelops called fragment packets. Succulent plants are not mounted on herbarium sheets but are collected in 4% formalin or FAA (Formalin Acetic Alcohol). Sewing is restricted to heavy stems, overlapping leaves, rhizomes, matted bases of grasses, large fruits, cones or heads, or other places where the use of plastic or glue is impossible or impractical. Threads on the back of sheets should be covered with linen or paper tape.

6. Labelling:

A label is pasted or printed on the lower right hand corner. The label should indicate necessary information recorded about the flora of, locality, altitude, habit, date of collection, name of collector, common name, complete scientific name, uses and any special note *etc*. The size of a herbarium label may vary but the recommendation is of 4x6 inches.

7. Deposition of mounted specimens:

Mounted, labelled and treated specimens are finally deposited in a herbarium, where they are properly stored and looked after.

8. Storage:

Properly dried, pressed and identified plant specimens are placed in thin paper folds (specimen covers) which are kept together in thicker paper folders (genus covers), and finally they are incorporated into the herbarium pigeon-holes in their proper position according to any accepted system of classification. In India Bentham and Hooker’s system of classification is followed.

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