

B.Sc.,

Botany

Semester - IV

Plant Ecology, Biodiversity and Phytogeography



Practicals

SYLLABUS

IV Semester

Course 10 : **Plant Ecology, Biodiversity and Phytogeography**

Credits -1

I. Course Outcomes : On successful completion of this practical course, student shall be able to:

1. Handle instruments used in ecological studies.
2. Perform experiments and collect data on autecology and synecology.
3. Identify various plant groups based on their morphological and anatomical adaptations.
4. Collect data on biodiversity and phytogeography.

II. Laboratory/field exercises:

1. Study of instruments used to measure microclimatic variables;

- a. Soil thermometer,
 - b. Maximum and minimum thermometer,
 - c. Anemometer,
 - d. Rain gauge,
 - e. Lux meter.
2. Visit to the nearest/local meteorology station where the data is being collected regularly and record the field visit summary for the submission in the practical.
 3. Study of morphological and anatomical adaptations of any two hydrophytes.

4. Study of morphological and anatomical adaptations of any two xerophytes.
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency, density and abundance.
6. Identification of vegetation/various plants in college campus and comparison with Raunkiaer's frequency distribution law.
7. Find out the alpha-diversity of plants in an area.
8. Mapping of biodiversity hotspots of the world and India.
9. Mapping of phytogeographical regions of the globe and India.

Study of Instruments used to measure microclimatic variables

(A) Soil thermometer :

1. This thermometer is specifically designed to measure soil temperature.
2. It is useful for farmers and gardeners to help them plan their plantings it may also be used for scientific purposes.
3. Soil thermometers is 30cm long, that allows them to reach deep into the soil, the probe is coated to help it resist corrosion.
4. A regular wipe down is recommended in order to remove any debris that may have adhered.
5. This thermometers need to be left in place for a few seconds in order to generate a stable reading.
6. They can also be left in place in greenhouses or other controlled environments for regular readings.
7. Temperature range from -10° to 110°C .

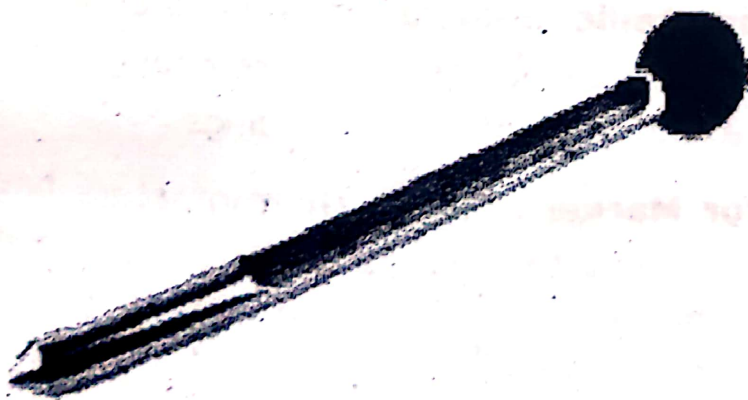


Fig : Soil-Thermometer

(B) Maximum and Minimum thermometer :

A maximum and minimum thermometer is a type of thermometric device used to measure the highest and lowest temperatures over a specific period, typically in meteorological and environmental contexts. Here are the key features and characteristics of maximum and minimum thermometers:

Design and Structure :

- 1. Dual Scale :** These thermometers usually have two separate scales to indicate maximum and minimum temperatures. The scales may be in Celsius, Fahrenheit, or both.

2. Bimetallic or Liquid-Filled :

(i) **Liquid-filled:** Often filled with alcohol or mercury, where the liquid expands and contracts with temperature changes. The maximum temperature is recorded by a movable indicator, while the minimum temperature is indicated by another marker.

(ii) **Bimetallic:** Some designs use a bimetallic strip that bends with temperature changes to record maximum and minimum readings.

- 3. Indicator Markers:** These thermometers have two indicators — one that marks the highest temperature (maximum) and another that marks the lowest temperature (minimum).

- 4. Graduated Scale:** The scale is calibrated to provide clear readings of temperature changes.

Functionality :

1. **Maximum Temperature Indicator:** As the temperature rises, the liquid expands and moves up the capillary tube. When it reaches the highest point, a small marker (usually a metal or glass rod) traps the liquid, indicating the maximum temperature.
2. **Minimum Temperature Indicator:** When the temperature falls, the liquid contracts. A small movable indicator drops to show the lowest temperature reached.
3. **Resetting:** To reset the maximum and minimum thermometer, a small lever or button is usually provided to allow the user to return the indicators to the starting point after recording the measurements.

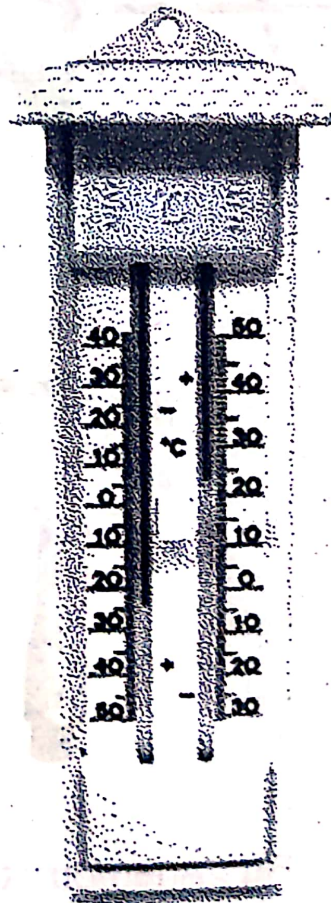


Fig : Maximum & Minimum Thermometer

(c) Anemometer :

This is used to record the wind speed.

- (i) This instrument has cups mounted on a pivot revolve at speeds proportionate to the velocity of wind.
- (ii) This instrument, has several blades in the centre and revolve much like the blades of a fan.

By using this instrument the wind velocity in kilometres per hour (or) metres per minute is recorded with the help of a watch.

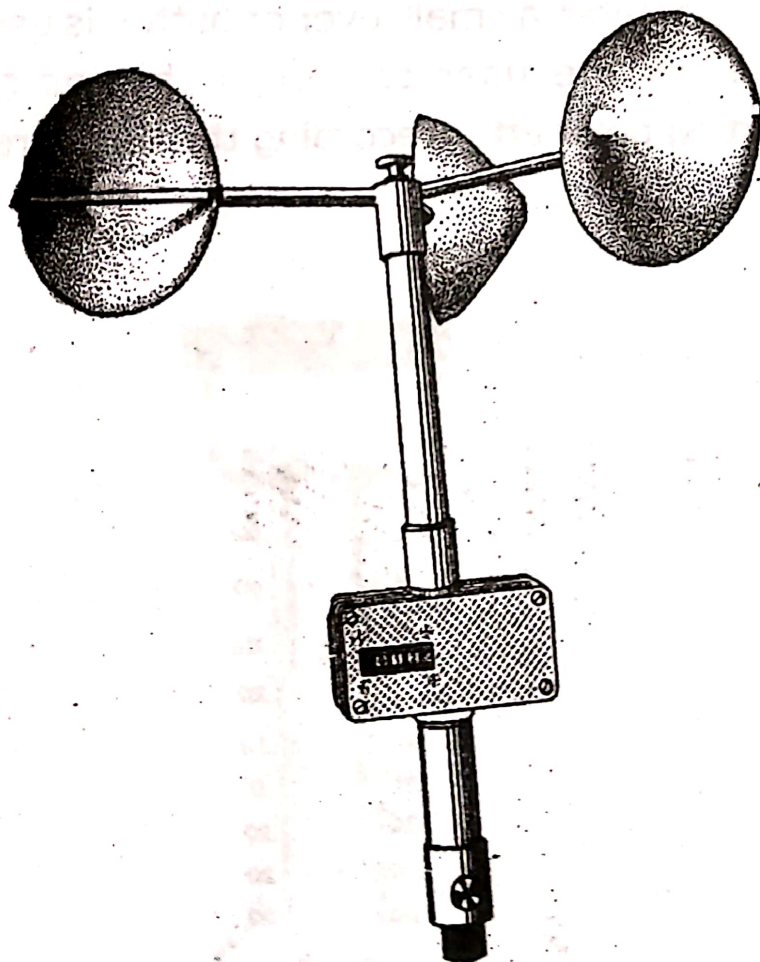


Fig : Anemometer

(D) Rain gauge :

This is simple instrument used to measure rainfall.

This consists of a drum; a cap attached to a funnel and a measuring cylinder. This is permanently fixed in a open place. Daily at 8-00 A.M the cap is removed and the quantity of rain water in the graduated cylinder fallen in the previous 24 hours is noted. The quantity of rainfall is usually expressed in terms of millimetres (or) centimetres.

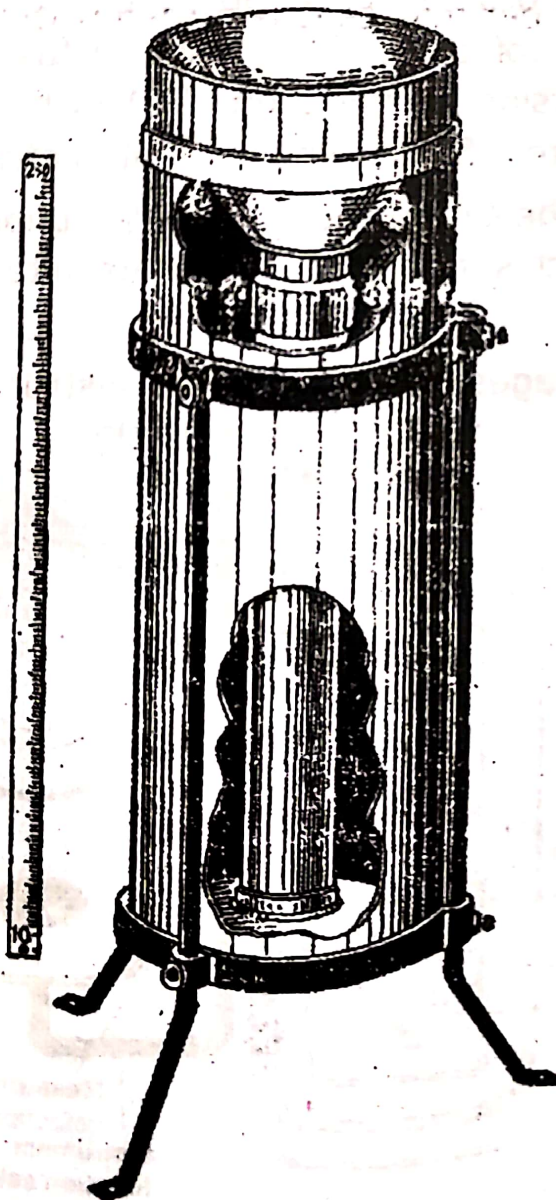


Fig : Rain Gauge

(e) Photometer (or) Luxmeter :

This instrument is used to measure the intensity or brightness of light. This contains two parts (1) Photoelectric cell (2) Amperemeter.

The light energy falling on a photo - cell generates electrical current in proportion of the light intensity and it is read in the amperemeter. The light intensity also indicated in lux units. The luxmeter used to measure light intensity under water has a micro amperemeter connected through a long electric cord to a photo cell. The photo cell is placed in a transparent water proof case. This helps in taking the light intensity reading outside at the shore (or) in boat while the photocell is lowered to different known depths of water.

Precaution : The sensitive surface of the photocell should not be exposed to direct sun without adequate filters of known values.

Direct sun damages (or) solarizes the instrument.



Fig : Lux meter

Visit to the nearest/local meterology station where the data is being collected regularly and records the field visit summary for the submission in the practical

Study of morphological and anatomical adaptations of any two hydrophytes

Morphological Adaptations

(1) Eichhornia :

- (i) Free floating hydrophyte.
- (ii) Root system well developed having tufts of balancing roots.
- (iii) Root hairs are absent.
- (iv) Root pockets are present instead of root caps.
- (v) Leaf petiole becomes swollen and sponge. It helps in buoyance.
- (vi) Reproduction is by runner method.

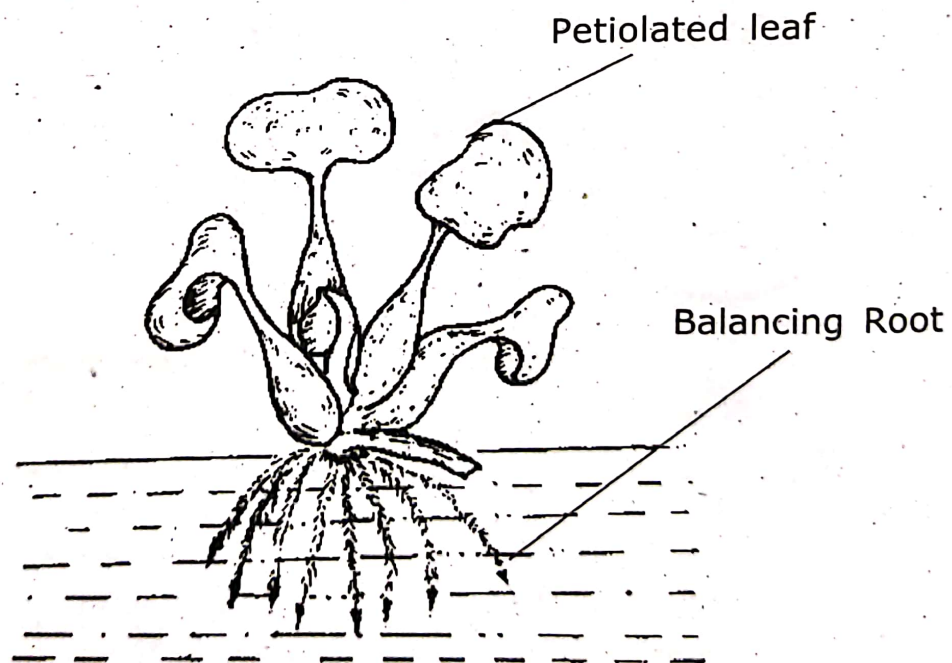


Fig : Eichhornia

(2) Pistia :

(a) Morphology :

- (i) This is a free floating hydrophyte.
- (ii) Roots are well developed and contains balancing roots.
- (iii) Root pockets are present instead of rootcaps. Root hairs absent.
- (iv) Stem is very much reduced and has rosette of broad leaves on the water surface.
- (v) Reproduction is by off-set method.

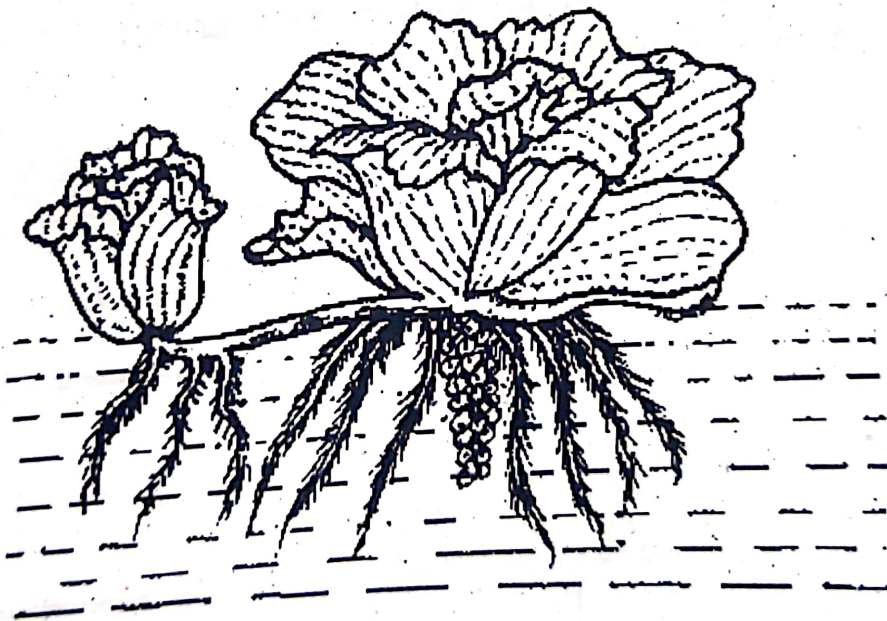


Fig : Pistia

Anatomical Adaptations

(1) *Hydrilla* stem T.S :

- (i) Single layered epidermis with thin walled cells and without cuticle.
- (ii) Cortex contains many layers of cells with Aerenchyma having air chambers.
- (iii) Single layered diaphragms are present in between two air chambers.
- (iv) Two (or) three layers of parenchymatous cortical cells are present below the epidermis and above the endodermis.
- (v) Central vascular tissue is covered by well developed endodermis and pericycle.
- (vi) Extremely reduced xylem and comparatively well developed phloem is present.

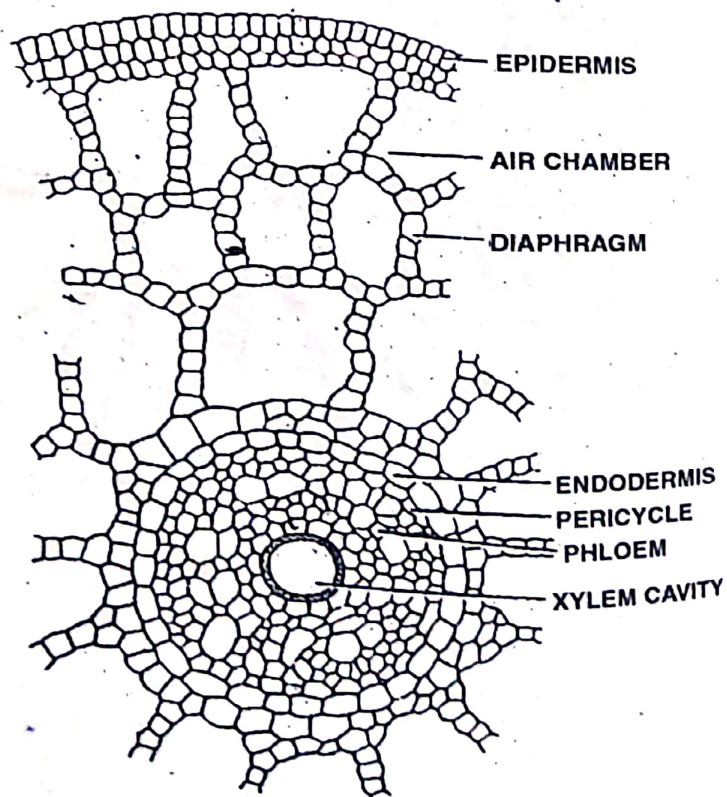


Fig : *Hydrilla* Stem T.S

(2) T.S. of *Nymphaea* petiole :

- (i) Presence of single layered with thin walled epidermis.
- (ii) Presence of thin walled cuticle (or) without cuticle.
- (iii) Chloroplasts are present in the epidermal cells.
- (iv) Presence of unbranched; multicellular epidermal hairs.
- (v) Presence of two (or) three layers of collenchymatous hypodermis below the epidermis.

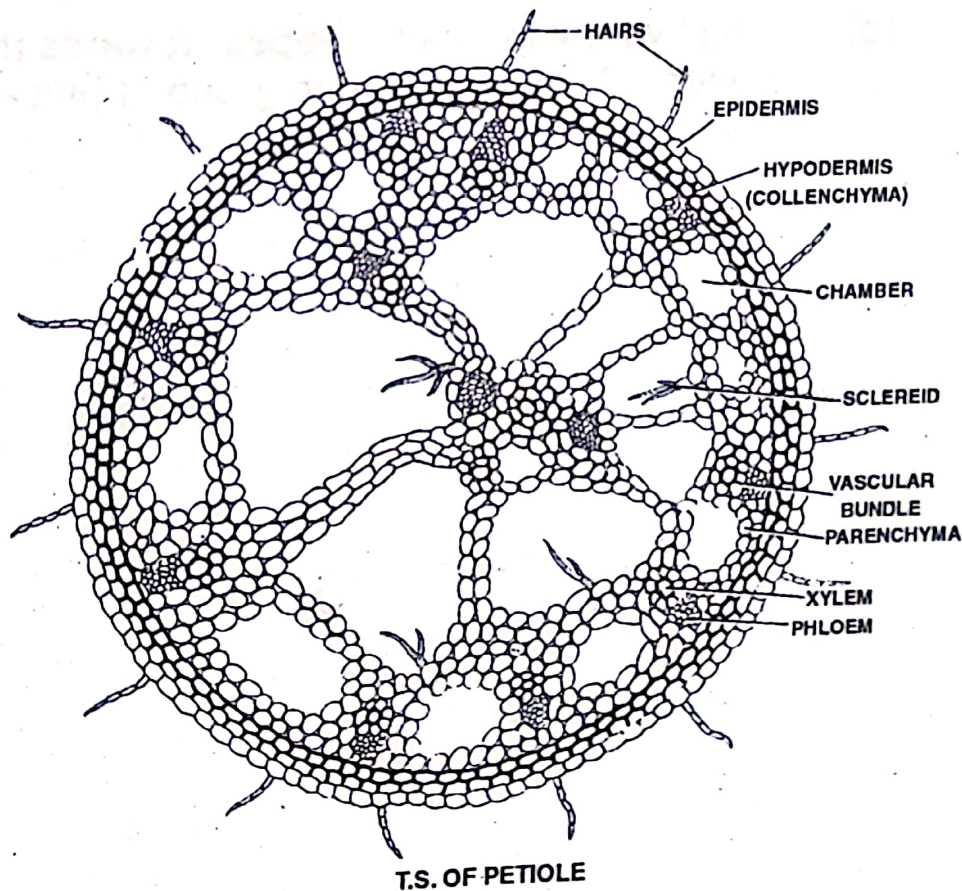


Fig : T.S. of *Nymphaea* Petiole

- (vi) Presence of large ground tissue with many; scattered airchambers having internal hairs.
- (vii) Many vascular bundles are distributed through out the ground tissue (Generally they occur in parenchyma between air chambers).

- (viii) Each vascular bundle has reduced xylem represented by a single lacuna. Phloem is normal and present towards outer side. Each V.B is Conjoint; collateral and closed.
- (ix) Two types of vascular bundles are present.
- (a) Large vascular bundles appear towards the centre. They contain phloem on either side of the xylem.
 - (b) Small vascular bundles appear towards the periphery. They contain one group of phloem.

Study of morphological and anatomical adaptations of any two xerophytes

Morphological Adaptation

(1) Opuntia :

- (i) This is a xerophytic, phylloclade.
- (ii) Stem is flat succulent and green.
- (iii) Leave modify in to spines.
- (iv) Aerole (barb+spine) is present at each node.
- (v) The phylloclade contains outer thick cuticle and water is present in the form of mucilage.

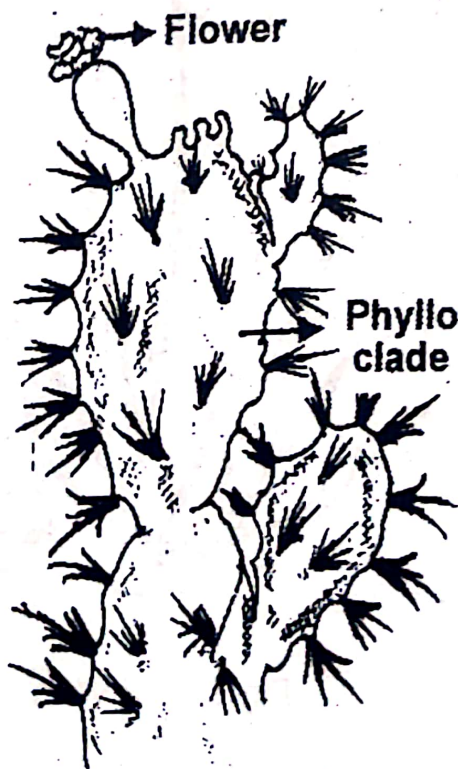


Fig : Opuntia

(2) Aloe vera :

1. Thick, fleshy leaves store water, allowing the plant to survive long periods without rainfall.
2. Reduces water loss through evaporation, helping to retain moisture through thick cuticle.
3. Stomata are fewer and often located in depressions on the leaf surface to minimize exposure to dry air.
4. Its shallow fibrous root system quickly absorbs moisture from rainfall and prevents deep water loss.
5. The leaves are adapted to reduce transpiration, ensuring water conservation in arid conditions.



Fig : Aloe vera

Anatomical Adaptation

(1) T.S of Nerium Leaf :

The internal structure of a Nerium leaf (commonly known as oleander) exhibits several xerophytic adaptations that enable it to thrive in dry environments. Here's a description highlighting these features:

1. **Upper Epidermis** : The upper epidermis is covered by a thick cuticle that reduces water loss through evaporation. This waxy layer helps to protect the leaf from harsh sunlight and minimizes transpiration.
2. **Mesophyll** : The mesophyll consists of two layers:
 - (i) **Palisade Mesophyll** : This layer contains elongated cells packed with chloroplasts, facilitating maximum light absorption for photosynthesis. The palisade cells are typically located near the upper epidermis.
 - (ii) **Spongy Mesophyll** : Below the palisade layer, the spongy mesophyll contains loosely arranged cells with large intercellular spaces. This structure allows for gas exchange while maintaining moisture retention.
3. **Lower Epidermis** : The lower epidermis has fewer stomata, which are often sunken in depressions. This adaptation reduces water loss by minimizing the exposure of stomata to dry air. The presence of guard cells helps regulate the opening and closing of these stomata, further controlling transpiration.
4. **Vascular Bundles** : The leaf contains well-developed vascular bundles (xylem and phloem) within the mesophyll. The xylem transports water and minerals from the roots, while the phloem distributes nutrients and

photosynthetic products. The arrangement of vascular tissue supports efficient transport while minimizing water loss.

- 5. Air Spaces :** The intercellular air spaces in the spongy mesophyll allow for efficient gas exchange, enabling the leaf to uptake carbon dioxide while retaining moisture.

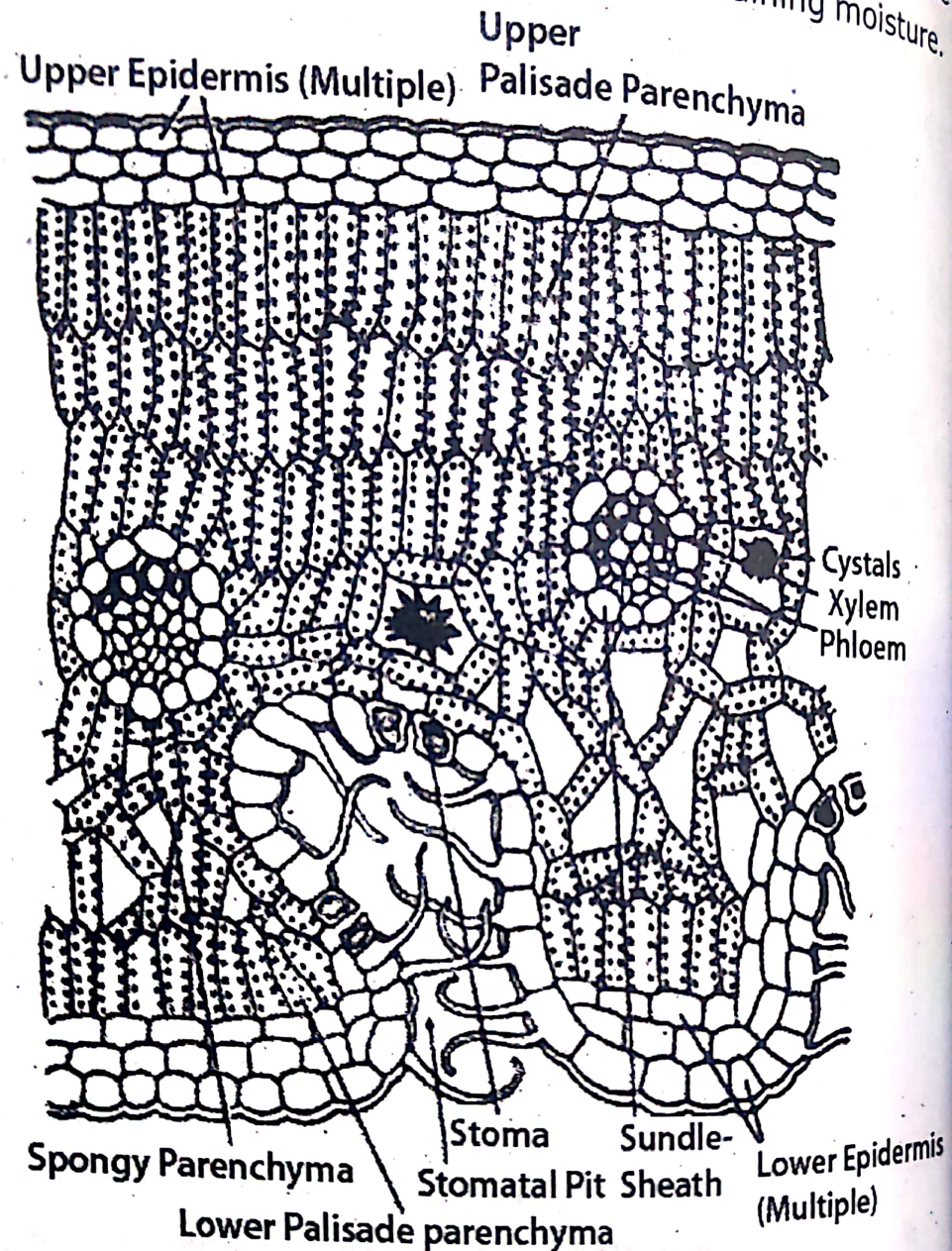


Fig : T.S. of Nerium (oleander)

(2) T.S of **Casuarina** Phylloclade :

The internal structure of **Casuarina** phylloclades (the leaf-like stems of the Casuarina tree) exhibits several adaptations that help the plant thrive in arid environments. Here's a description of its internal structure:

1. **Epidermis:** The outermost layer is composed of a thick epidermis that helps reduce water loss. The epidermal cells may contain a waxy cuticle, providing additional protection against desiccation.
2. **Photosynthetic Tissue:** Unlike typical leaves, the phylloclades of Casuarina have a unique arrangement where the green stem functions as the photosynthetic organ. The chlorenchyma (photosynthetic tissue) is distributed throughout the stem, allowing for efficient photosynthesis.
3. **Parenchyma Cells :** Beneath the epidermis, there are parenchyma cells that are loosely arranged, providing flexibility and allowing for gas exchange. These cells may also contain chloroplasts for photosynthesis.
4. **Vascular Tissue:** The vascular bundles are arranged in a ring or scattered throughout the phylloclade. Each bundle contains xylem and phloem:
 - (i) **Xylem:** Transports water and minerals from the roots. The xylem vessels are adapted to withstand high pressure.
 - (ii) **Phloem:** Conducts the products of photosynthesis from the phylloclades to other parts of the plant.

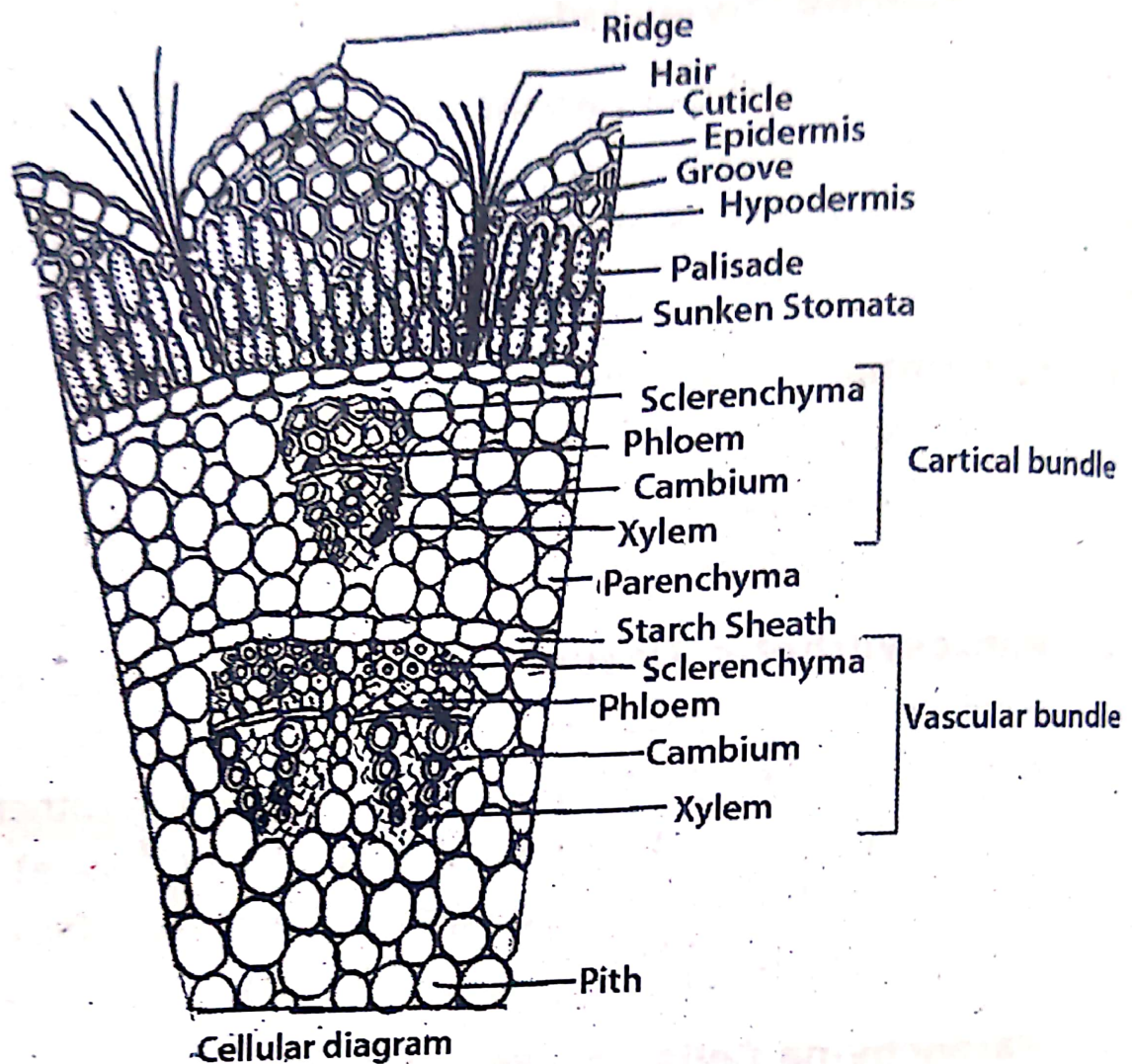


Fig : Casuarina : T.S. of Stem

5. **Air Spaces** : Intercellular air spaces are present within the parenchyma, facilitating gas exchange (oxygen and carbon dioxide) and enhancing the plant's ability to carry out photosynthesis even in arid conditions.
6. **Resin Ducts** : Casuarina phylloclades may contain resin ducts that secrete resin, which can deter herbivores and reduce water loss through additional protective mechanism.

Quantitative analysis of herbaceous vegetation in the college campus for frequency Density and Abundance

Experiment No : I

Aim : To study the frequency of herbaceous species in grassland and to compare the frequency distribution with *Raunkair's* standard frequency diagram.

Requirements : Quadrats of required size, measuring tape, paper, pencil etc.,

Procedure :

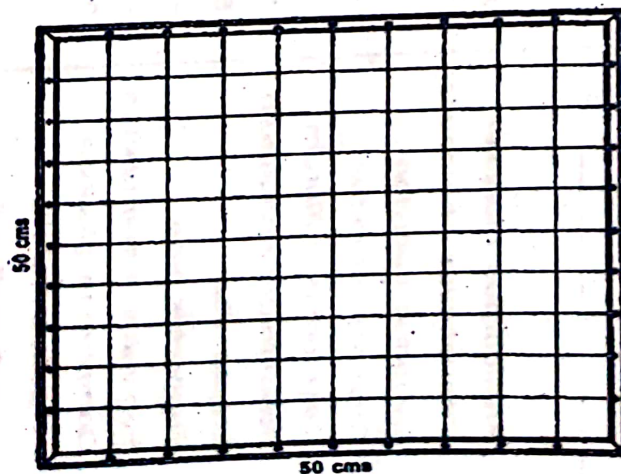
(a) Line transect method :

To study the frequency of herbaceous species in grassland, generally line transect method is used.

In this method a measuring tape or a cord marked into one meter segments is used.

Place this tape or cord across the grassland in north-south direction.

Note the presence or absence of plant species in each one meter segment. Consider only those plant species which touch the cord or tape.



A quadrat

Serial no.	Name of the Plant Species	No. quadrat segments					Total No. of species	Total No. of quadrats in which species occurred	Total No. of quadrats studied	Frequency	Frequency Class	Density	Abundance
		1	2	3	4	5							
1.	<i>Alysicarpus monilifer</i>	5	5	-	-	-	10	2	5	40	B	2	5
2.	<i>Convolvulus pluricaulis</i>	10	-	-	-	-	10	1	5	20	A	2	10
3.	<i>Cynodon dactylon</i>	15	10	12	13	15	65	5	5	100	E	13	13
4.	<i>Cyperus rotundus</i>	-	6	-	-	-	6	1	5	20	A	2	6
5.	<i>Desmodium triflorum</i>	-	12	-	-	-	12	1	5	20	A	2.4	12
6.	<i>Dichanthium annulatum</i>	12	-	12	10	11	45	4	5	80	D	9	11.25
7.	<i>Eclipta alba</i>	5	6	-	-	4	15	3	5	60	C	3	5
8.	<i>Euphorbia hirta</i>	-	-	-	6	-	4.10	2	5	40	B	2	5
9.	<i>Evolvulus nummularius</i>	-	-	3	-	-	3	1	5	20	A	0.3	6
10.	<i>Gomphrena globosa</i>	2	4	3	1	2	12	5	5	100	E	2.4	2.4
11.	<i>Indigofera tinctoria</i>	-	-	-	6	-	6	1	5	20	A	1.2	6
12.	<i>Leucaena nuda</i>	-	-	-	-	3	3	1	5	20	A	0.6	3
13.	<i>Phyllanthus niruri</i>	-	-	-	-	2	2	1	5	20	A	0.4	2
14.	<i>Rhynchosia minima</i>	-	-	-	4	3	7	2	5	40	B	1.4	3.5
15.	<i>Sida cordifolia</i>	-	-	-	6	4	2.12	3	5	60	C	2.4	4
16.	<i>Vernonia cinerea</i>	-	-	11	-	-	11	1	5	20	A	2.2	11

Number of plants in each frequency class. A = 8, B = 3, C = 2, D = 1, E = 2

(b) Quadrat method :

1. To study grass lands, square type quadrats of eg. 50x50 cm or 20x20 cm should be used.
2. Lay down the quadrat randomly at number of places (minimum of 5 places).
3. Identify as many number of plant species and list them (1st column of the table).
4. Take the data on no. of species observed in individual quadrats (column 2).
5. From this data calculate the frequency (%) of each species and classify them in to different classes (Raunkaier, 1934) according to their percentage of occurrence.

Calculate of the percentage frequency as given below.

$$\text{Frequency (\%)} = \frac{\text{Total no. of quadrats in which a species occurred}}{\text{Total number of quadrats studied}} \times 100$$

Frequency (%)	Frequency class
1-20 %	A
21-40 %	B
41-60 %	C
61-80 %	D
81-100%	E

Distribution of frequency classes

6. Write down the frequency class in appropriate column against each species.
7. Note down the distribution of all plant species identified in to five frequency classes. i.e., no. of species belongs to each class (A,B,C,D,E).

In the given data A = 8, B = 3, C = 2, D = 1 and E = 2.

8. Then calculate the percentage of species belonging to different classes as follows out of the total number of species recorded

$$\text{Percentage of total number of species} = \frac{\text{No. of species falling in frequency class}}{\text{Total number of species recorded}} \times 100$$

$$\text{For frequency class A} = 8/16 \times 100 = 50$$

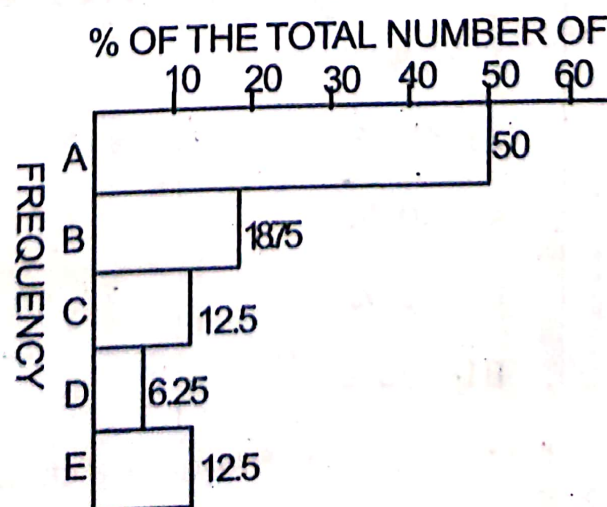
$$B = 3/16 \times 100 = 18.75$$

$$C = 2/16 \times 100 = 12.5$$

$$D = 1/16 \times 100 = 6.25$$

$$E = 2/16 \times 100 = 12.5$$

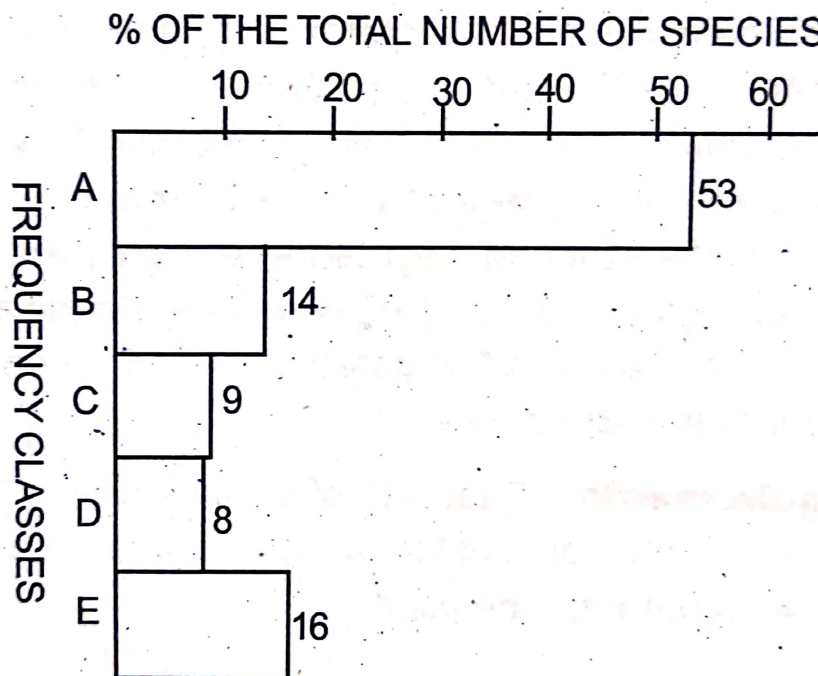
9. Draw the Histogram by taking percentage of the total no. of species on y-axis and the frequency classes on x - axis. This is known as frequency diagram.



Frequency diagram of the place studied

10. Compare the frequency diagram with that of Raunkiaer's normal frequency diagram. When values of frequency classes B, C, and D are comparatively higher than their values in normal frequency diagram, the vegetation is said to be **homogenous**, higher values of class E indicate **heterogeneity** of vegetation.

$$A > B > C \approx D < E$$



Raunkiaer's normal frequency diagram

Identification of Vegetation/Various Plants - Compare with Raunkiner's Frequency distribution law

Experiment No. I

Aim : To study the vegetation profile of an area using multiple quadrat method.

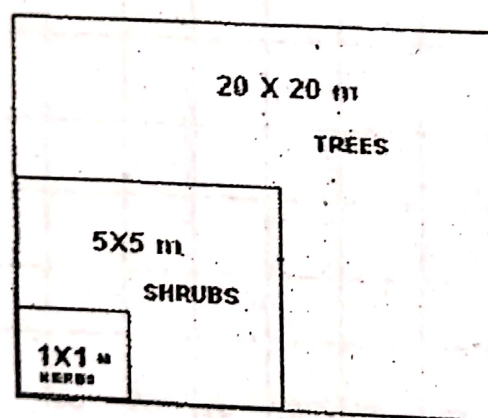
Principle : Herbs, shrubs and trees are the three different strata that constitute any vegetation. Their frequency and density differ in different vegetations. Except in grassland vegetation, which is rich with herbs, in other fully developed vegetations all these three strata are commonly seen. In a given locality the study of vegetation will give an idea about the dominant group (status) of plants. A simple method to assess the composition of vegetation in any given locality is multiple quadrat method.

Requirements : Quadrats of various sizes (20 x 20 m) OR (40 x 40 m) etc., alternately a rope or a graduated tape of the required length can be used.

Procedure : (Multiple Quadrat method)

1. Lay down a suitable sized (20 x 20 m) quadrat in the study locality.
2. Within the selected (20 x 20 m) quadrat, first mark a small quadrat region eg. 1 x 1m (as shown in the figure) and note down the number of *herbaceous* species only in that small quadrat.
3. Within the original quadrat next, mark a slightly bigger quadrat e.g. 5 x 5m (as shown in the figure) and note down *only shrub* species in the total space of 5 x 5 m.

4. In the total space of original 20 x 20m quadrat (as shown in the figure) note down *only the tree* species.
5. Count the number of plants and identify the species in all the three types of quadrats.
6. Repeat the same type of multiple quadrat (3 in 1) study by laying down the quadrat at a minimum of 5 places in the locality.
7. Enter the data on names of the species, their numbers in each quadrat and calculate the frequency (%) and density of each species in a table.
8. Record the total no. of quadrats in which a species occurred in the table.



MULTIPLE QUADRAT METHOD

Calculate the density by using the following formula

$$\text{Density} = \frac{\text{Total no. of individuals}}{\text{Total no. of quadrats (5)}}$$

Observations :

Table (modal data sheet)

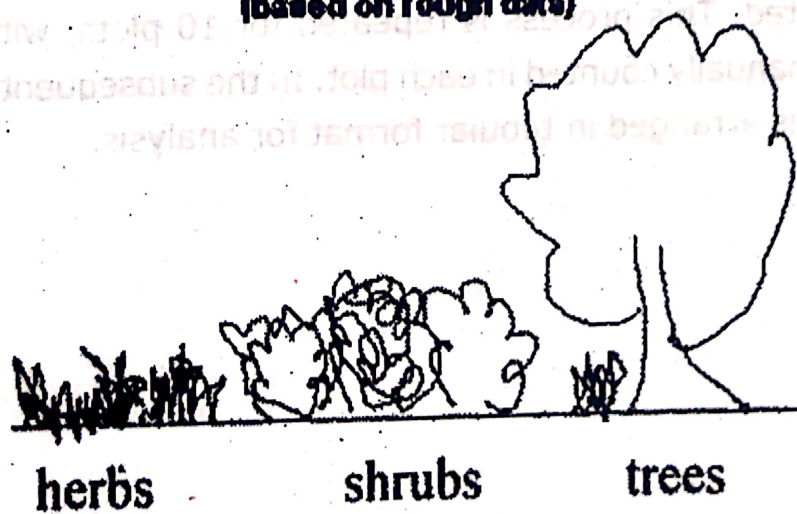
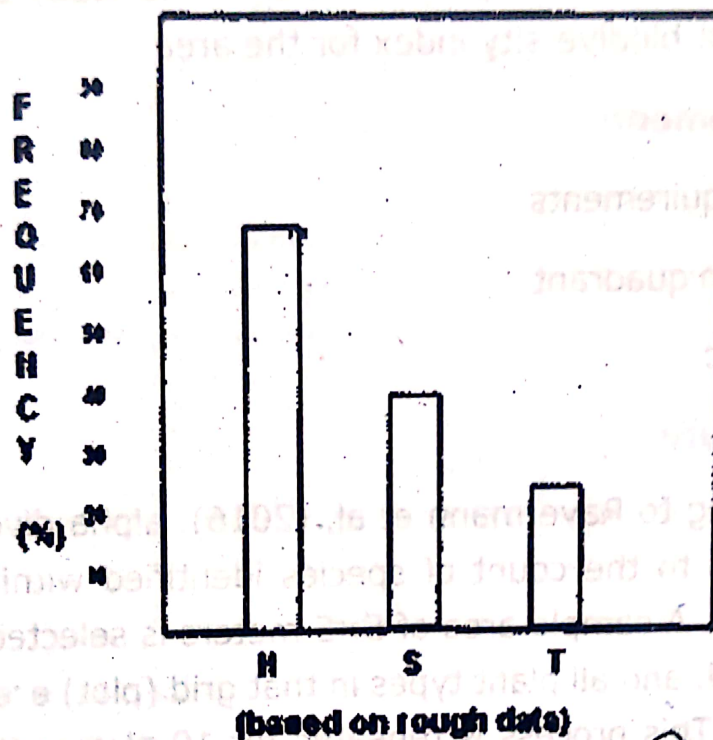
Sl No.	Name of the species	Stature of the species	Qadrat No.s					Total no. of quadrats in which a species occurred	Total No. of individuals	Frequency	Density
			1	2	3	4	5				
1	<i>Cynodon dactylon</i>	H									
2	<i>Cyperus rotundus</i>	H									
3	<i>Desmodium repans</i>	H									
4	<i>Phyllanthus neruri</i>	H									
5	<i>Euphorbia hirta</i>	H									
6	<i>Tephrosia purpuria</i>	S									
7	<i>Rhynchosia suaveolens</i>	S									
8	<i>Indigophera hirsute</i>	S									
9	<i>Terminalia arjuna</i>	T									
10	<i>Cassia fistula</i>	T									

H = herb; S = shrub; T = tree

Draw a phytogram (histogram) for all the three strata by taking the frequency values and identify the dominant strata.

Based on the modal data diagram herbs are the dominant strata in the given locality.

Vegetation profile (based on density) of the given locality.



Find out Alpha - Diversity of Plants

Alpha diversity is a quantitative measure of species richness within a given habitat or ecosystem, such as a forest stand, grassland, or stream.

Aim : To count the plant species in the study area and prepare a plant biodiversity index for the area.

Requirements :

Write requirements

Pins, iron quadrant

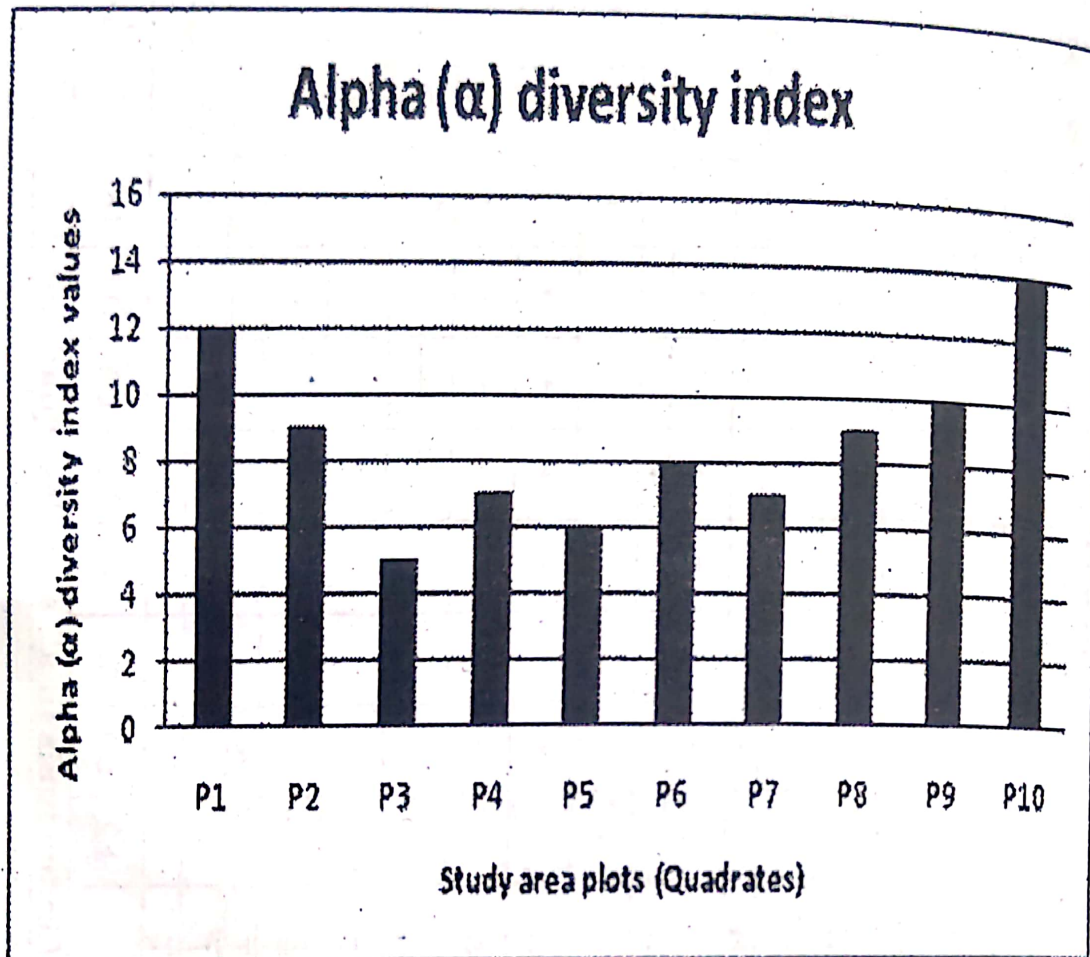
Tape etc

Procedure :

According to Ravermann et al.. (2016), alpha diversity is often equated to the count of species identified within a defined plot size. A sample area of 5×5 meters is selected within the study field, and all plant types in that grid (plot) are manually counted. This process is repeated for 10 plots, with plant species manually counted in each plot. In the subsequent phase, the data is arranged in tabular format for analysis.

S.No	Name of the plant species	Habitat	Studied plots (Quadrates)										TNI	TQO
			P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		
1	<i>Hemidesmus indicus</i>	CH	+										5	01
2	<i>Ipomoea nil</i>	CH	+							+	+	+	08	04
3	<i>Ipomea hederifolia</i>	CH	+			+	+				+	+	12	06
4	<i>Mucuna monosperma</i>	CS										+	02	01
5	<i>Pueraria tuberosa</i>	CS	+								+	+	12	03
6	<i>Acalypha indica</i>	H	+	+		+	+		+		+	+	20	08
7	<i>Achyranthes aspera</i>	H	+	+								+	10	03
8	<i>Aerva lanata</i> *	H	+	+	+	+		+	+	+	+	+	45	09
9	<i>Alternanthera versicolor</i>	H	+	+		+	+	+	+	+		+	24	08
10	<i>Cassia auriculata</i>	S					+	+	+				06	03
11	<i>Cassia occidentalis</i>	S	+							+	+	+	14	04
12	<i>Eupatorium odoratum</i> *	S		+	+	+	+	+	+	+	+	+	54	09
13	<i>Hyptis suaveolens</i>	S		+	+	+	+	+	+	+	+	+	41	09
14	<i>Albizia procera</i>	T								+			04	01
15	<i>Annona squamosa</i>	T	+								+	+	09	03
16	<i>Borassus flabellifer</i>	T				+			+				18	02
17	<i>Delonix regia</i>	T						+		+			12	02
18	<i>Ficus hispida</i>	T		+									06	01
19	<i>Ficus religiosa</i>	T		+									01	01
20	<i>Murrayakoenigii</i>	T	+	+						+	+	+	24	05
	<i>Pongamia pinnata</i>	T										+	02	01
Number of species in each quadrat			12	09	05	07	06	08	07	09	10	14		
Total number of individuals in all samples (quadrants)													329	

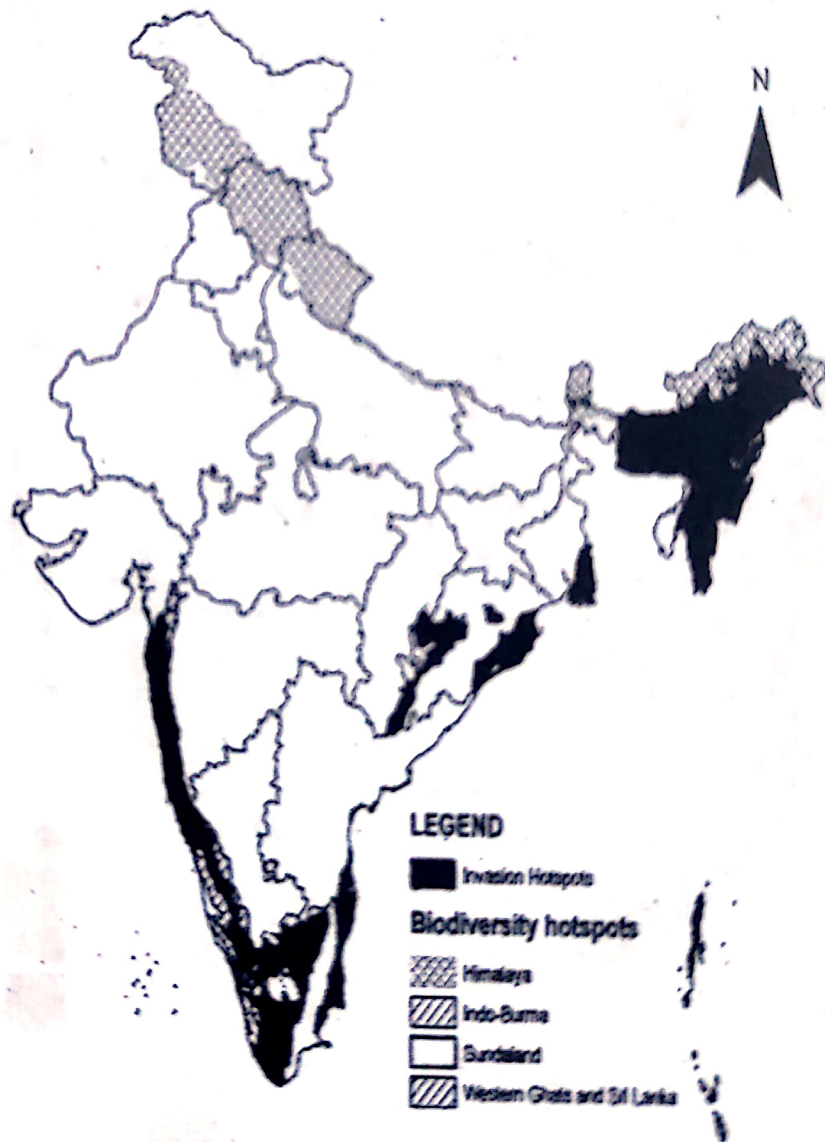
P-Plot or quadrat; Count saplings also for trees;
TNI- Total number of Individuals ; TQO –Total quadrates occurrence; Five species (marked with *) occur in only one quadrat and are thus defined as unique species.

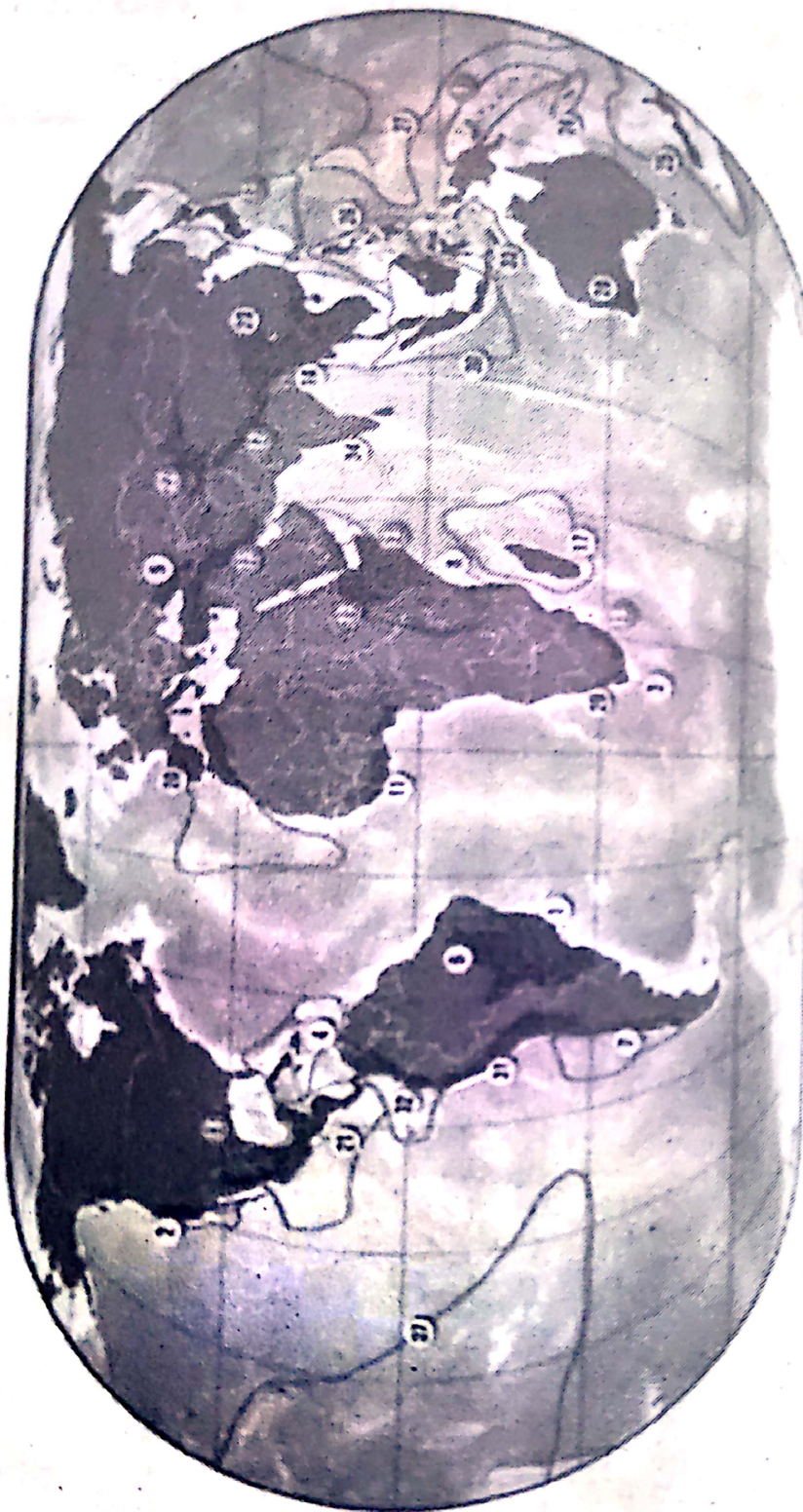


Results : Alpha (α) diversity indices for P1 to P10 Plots show specific patterns in plant biodiversity. The P10 plot shows the highest diversity index of 14 followed by Plot P1, indicating a rich and evenly distributed assortment of plant species. This suggests a rich and ecologically balanced habitat. In contrast, other Plots, with diversity index of 10 to 06 displays a moderately diverse plant community, while the plot P3 records the lowest diversity index of 05, indicating a less diverse and potentially less stable ecosystem.

Mapping of Biodiversity of Hot spots of the World and India

BIODIVERSITY HOTSPOTS IN INDIA





Biodiversity Hotspots

Earth's biologically richest places, with high numbers of species found nowhere else. Hotspots face extreme threats and have already lost at least 70 percent of their original vegetation.

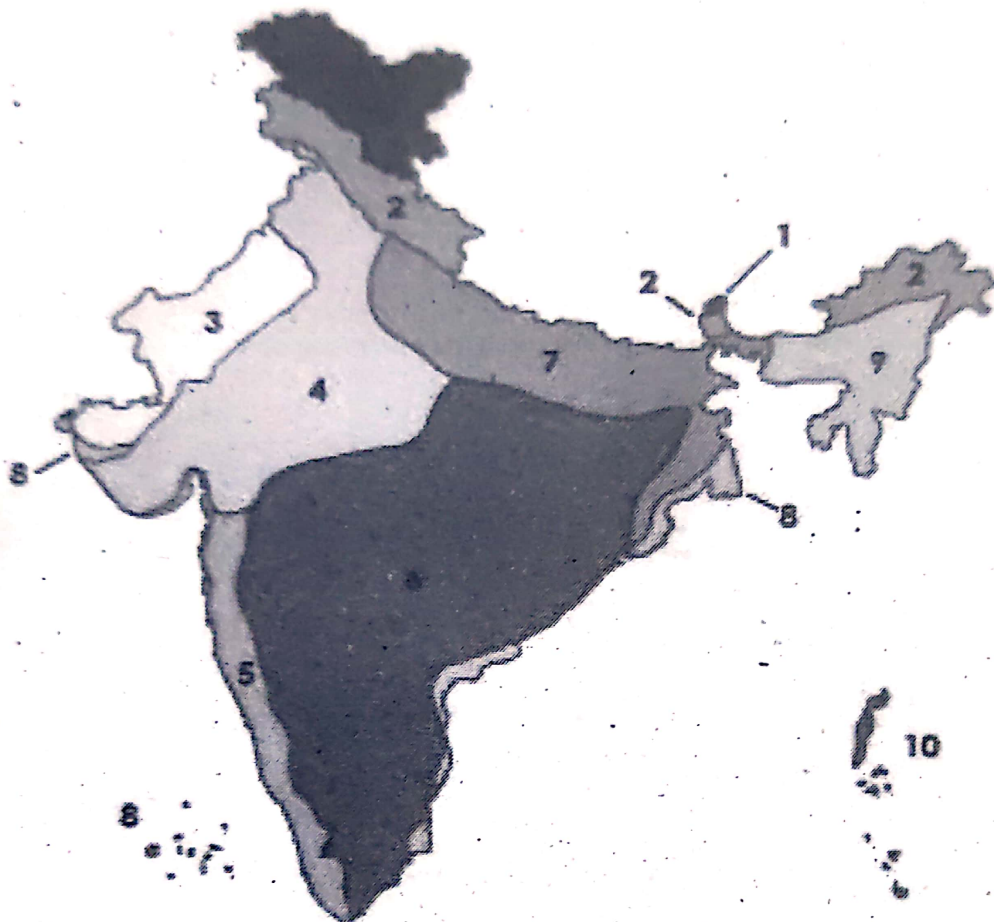
- 1 Atlantic Forest
- 2 California Floristic Province
- 3 Cape Floristic Region
- 4 Caribbean Islands
- 5 Caucasus
- 6 Cerrado
- 7 Chocó and Western Rumbia
- 8 Madagascari Forests of Eastern Africa

- 9 East Melanesian Islands
- 10 Eastern Afromontane
- 11 Guinean Forests of West Africa
- 12 Himalaya
- 13 Horn of Africa
- 14 Indo-Burma
- 15 Indo-Australian
- 16 Japan
- 17 Madagascar and Indian Ocean Islands

- 18 Madagascan Pine Old Woodlands
- 19 Maguireland-Pandanus-Albury
- 20 Mediterranean Basin
- 21 Miconia
- 22 Mountains of Central Asia
- 23 Mountains of Southwest China
- 24 New Caledonia
- 25 New Zealand
- 26 Philippines
- 27 Polynesian-Micronesian

- 28 Southwest Australia
- 29 Succulent Karoo
- 30 Sundaland
- 31 Tapaia Andes
- 32 Tanimbar-Oban-Magdalena
- 33 Wallacea
- 34 Western Ghats and Sri Lanka

Mapping of Phytogeographical regions of the Globe and India



- 1. Trans Himalaya
- 2. Himalaya
- 3. Desert
- 4. Semi Arid
- 5. Western Ghats
- 6. Deccan Peninsula
- 7. Gangetic Plain
- 8. Coasts
- 9. North East
- 10. Islands