PLANT ECOLOGY AND BIODIVERSITY AND PLANT PHYSIOLOGY

M.Sc. BOTANY

SEMESTER-II, PAPER-V

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M.Sc. BOTANY: PLANT ECOLOGY AND BIODIVERSITY AND PLANT PHYSIOLOGY

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FOREWORD

Since its establishment in 1976, Acharya Nagarjuna University has been forging ahead in the path of progress and dynamism, offering a variety of courses and research contributions. I am extremely happy that by gaining 'A+' grade from the NAAC in the year 2024, Acharya Nagarjuna University is offering educational opportunities at the UG, PG levels apart from research degrees to students from over 221 affiliated colleges spread over the two districts of Guntur and Prakasam.

The University has also started the Centre for Distance Education in 2003-04 with the aim of taking higher education to the door step of all the sectors of the society. The centre will be a great help to those who cannot join in colleges, those who cannot afford the exorbitant fees as regular students, and even to housewives desirous of pursuing higher studies. Acharya Nagarjuna University has started offering B.Sc., B.A., B.B.A., and B.Com courses at the Degree level and M.A., M.Com., M.Sc., M.B.A., and L.L.M., courses at the PG level from the academic year 2003-2004 onwards.

To facilitate easier understanding by students studying through the distance mode, these self-instruction materials have been prepared by eminent and experienced teachers. The lessons have been drafted with great care and expertise in the stipulated time by these teachers. Constructive ideas and scholarly suggestions are welcome from students and teachers involved respectively. Such ideas will be incorporated for the greater efficacy of this distance mode of education. For clarification of doubts and feedback, weekly classes and contact classes will be arranged at the UG and PG levels respectively.

It is my aim that students getting higher education through the Centre for Distance Education should improve their qualification, have better employment opportunities and in turn be part of country's progress. It is my fond desire that in the years to come, the Centre for Distance Education will go from strength to strength in the form of new courses and by catering to larger number of people. My congratulations to all the Directors, Academic Coordinators, Editors and Lesson-writers of the Centre who have helped in these endeavors.

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M.Sc. BOTANY

SEMESTER-II, PAPER-V

PRACTICAL-I

205BO24-PLANT ECOLOGY AND BIODIVERSITY AND PLANT PHYSIOLOGY

SYLLABUS

Plant Ecology and Biodiversity

1) Construction of Ombrothermic Diagram
2) Determination of Minimum size of a Quadrat by Species Area Curve Method
3) Determination of Frequency, Density and Abundance by Quadrat Method
4) Determination of Leaf Area and Kemp' s Constant
5) Determination of Leaf Area index
6) Soil Textural Analysis
7) Mapping of Hot Spots of India Mapping of Hot Spots of World
8) Mapping of National Parks and Biosphere Reserves in India
9) Identification of Endemic Species

Plant Physiology

1) Detemination of Water Potential
2) Demonstration of Osmosis by using Egg Membrane
3) Estimation of Seed Gemination as Effected by Red and Far-Red Radiation
4) Determination of Osmotic Potential of Cell Sap by Plasmolytic Method
5) Determination of Stomatal Index, Frequency and Pore Area
6) Effects of Temperature on the Permeability of Protoplasmic Membrane
7) Effects of Chemicals on the Permeability of Protoplasmic Membrane
8) Determination of Gibberellic Acid by Half Seed (Cereal) Method
9) Seed Viability Test

CONTENTS

EXERCISE-1

1) SPECIES – AREA – CURVE:

Aim: To determine the minimum size of the quadrat by 'Species-Area-Curve' method.

Requirements: One-meter metal quadrat, graph sheet, herbarium sheet and cellotape.

Procedure: With the help of rope or string, the one-meter metal quadrat is divided into 100 units; each unit is equivalent to 10 x 10 cm (Fig. 1.1). The quadrat is laid down on the vegetational plot. Note down the various species present within the area 10 x 10 cm. Now increase the area to 20 x 20 cm and record the species encountered in this area. Thus, go on increasing the area, i.e., 30 x 30 cm, 40 x 40 cm and so on (Fig. 1.1), each time recording the species occurring in that area. Continue the process till there is no further increase in the total number of species with the increasing size of the quadrat. Fix specimen of each species recorded on the herbarium sheet.

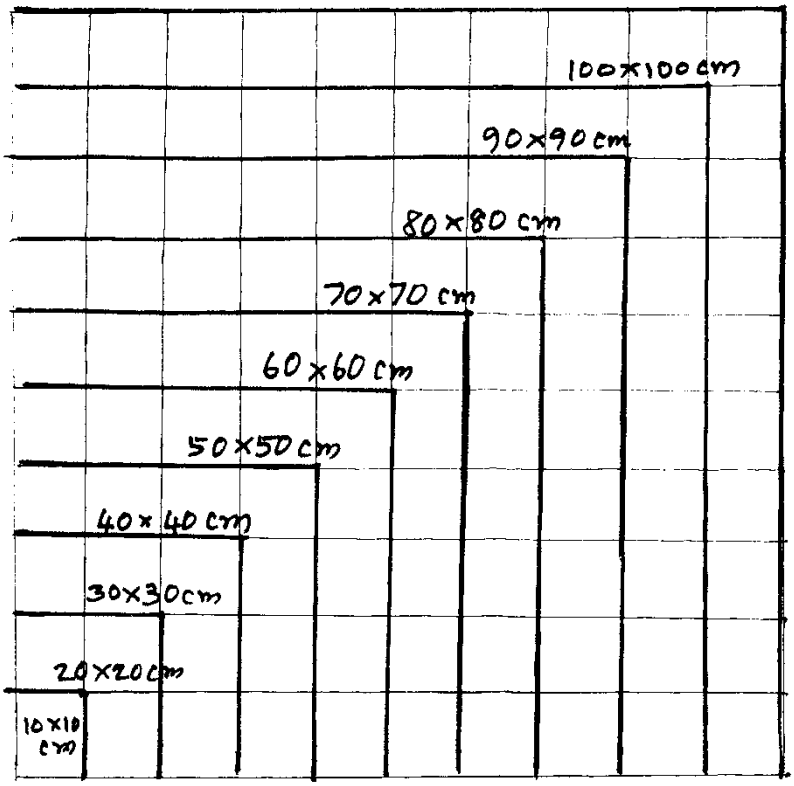

Fig. 1.1: One-Meter Metal Quadrat

(Each Square = 10 x 10 cm)

Observations: Data should be tabulated as shown in the Table 1.1.

Table 1.1: Number of Species Recorded

Area	Total number of species present (No. of species of previous square unit + No. of species added to next square unit)
10 x 10 cm = 100 cm	8
20 x 20 cm = 200 cm	8 + 4 = 12
30 x 30 cm = 300 cm	12 + 4 = 16
40 x 40 cm = 400 cm	16 + 3 = 19
50 x 50 cm = 500 cm	19 + 3 = 22
60 x 60 cm = 600 cm	22
70 x 70 cm = 700 cm	22

Take a graph sheet and plot the number of species on Y-axis against the area on the X-axis as shown in Fig. 1.2. Note the point at which this curve starts flattening up. From this point find out the area of the quadrat. This would be the minimum size of the quadrat to be taken for further study.

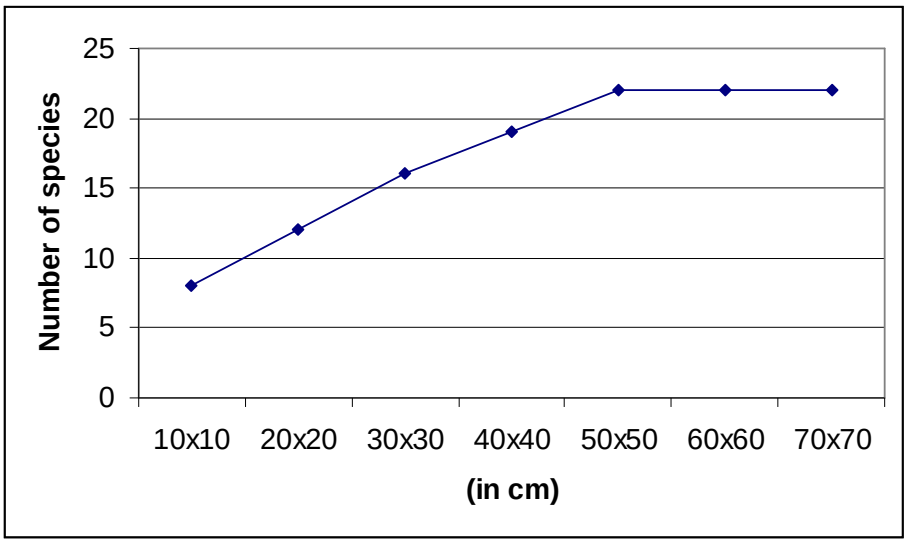

Fig. 1.2: Species-Area-Curve

In the above graph (Fig. 1.2) minimum size of the quadrat is 50 x 50 cm.

Discussion:

The size of a quadrat varies with the type of vegetation to be studied. For small plants like mosses, lichens and liverworts growing in patches, small quadrat of 20 cm x 20 cm size may be quite useful. In grasslands, if the stand is of relatively pure type, 50 x 50 cm size quadrat may serve the purpose; in grassland with great diversity one meter^2 or more may be needed. In forests the quadrat may be quite large, i.e., 10 meters x 10 meters or even bigger.

EXERCISE-2

2) SPECIES -QUADRAT-CURVE:

Aim: To determine the minimum number of quadrats to be laid down in the field under study by "Species-Quadrate-Curve" method.

Requirements: One-meter metal quadrat, graph sheet, herbarium sheet and cello tape.

Procedure: Lay down 10 quadrats randomly in the field at different sites. Record the different species encountered in each quadrat as shown in Table 1.2, find out the total number of species present in each quadrat.

Table 1.2. Number of Species in Each Quadrat

Quadrat Number	Number of New Species	Total Number of Species
1	--	12
2	6	18
3	5	23
4	6	29
5	4	33
6	4	37
7	3	40
8	--	40
9	--	40
10	--	40

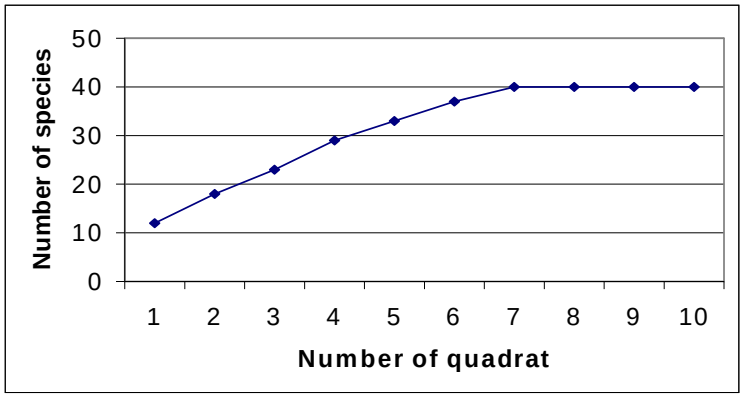

Fig. 1.3: Species-Quadrat Curve

On graph sheet, plot the number of quadrats on X-axis against total number of species on Y-axis. A curve is obtained, and the point at which curve starts flattening up would give the minimum number of quadrats to be laid down in the field. From the graph (Fig. 1.3), it is evident that seven quadrats is minimum number to study the vegetation of that particular site.

EXERCISE-3

3) QUANTITATIVE CHARACTERS OF PLANT COMMUNITY

Aim: To determine the frequency, density and abundance of different species present in the community and also to prepare frequency diagram by quadrat method.

Requirements: One-meter metal quadrat, graph sheet, herbarium sheet and cello tape.

Procedure: Lay down the required number of quadrats (10 quadrats) randomly in the area to be studied. In each quadrat, note down the various species and also count the number of individuals of each species.

Observations and Calculations: Field data should be tabulated as shown in Table 3. From this data, calculate the frequency, density and abundance of different species present in the community as follows:

$$\text{Frequency (\%)} = \frac{\text{Total number of quadrats in which species has occurred}}{\text{Total number of quadrat studied}} \times 100$$

$$= \frac{2}{10} \times 100 = 20\%$$

Frequency value of *Sida acuta* is 20%.

$$\text{Density} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats studied}} = \frac{10}{10} = 1$$

The density value of *Sida acuta* is 1 per mt^2 area.

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats in which the species has occurred}} = \frac{10}{2} = 5$$

Abundance value of *Sida acuta* is 5.

Table 1.3: List of Different Species and Other Data Recorded in the Field by Quadrat Method

S. No.	Name of the Species	Quadrats Laid Down										Total No. of Individuals of Species	Total No. of Quadrats of Occurrence	Total No. of Quadrats Studied	Frequency (%)	Frequency Class	Density	Abundance
		1	2	3	4	5	6	7	8	9	10							
1	*Sida acuta*	4	--	--	--	6	--	--	--	--	--	10	2	10	20	A	1	5
2	*Eclipta alba*	5	2	--	--	--	--	--	--	--	--	7	2	10	20	A	0.7	3.5
3	*Euphorbia hirta*	10	10	8	10	5	10	5	12	10	15	95	10	10	100	E	9.5	9.5
4	*Cassia tora*	4	6	--	--	--	--	--	--	--	--	10	2	10	20	A	1	5
5	*Xanthium strumarium*	5	--	--	--	--	--	4	6	--	--	15	3	10	30	B	1.5	5
6	*Indigofera trita*	2	3	--	--	5	--	--	--	2	--	12	4	10	40	B	1.2	3
7	*I. linifolia*	3	--	--	--	4	--	3	--	--	--	10	3	10	30	B	1	3.3
8	*Argemon mexicana*	5	--	--	2	--	--	3	--	--	2	12	4	10	40	B	1.2	3
9	*Crotan bonplandianum*	5	4	10	6	5	7	8	5	10	10	70	10	10	100	E	7	7
10	*Biophytum sensitivum*	5	6	4	10	8	7	10	5	15	10	80	10	10	100	E	8	8
11	*Calotropis procera*	5	4	3	3	5	5	--	6	4	5	40	9	10	90	E	4	4.4
12	*Gomphena globosa*	5	10	--	10	7	8	--	4	10	6	60	8	10	80	D	6	7.5
13	*Evolulus elsinoides*	5	10	--	10	7	--	8	10	4	6	60	8	10	80	D	6	7.5
14	*Argemone mexicana*	2	--	--	--	--	--	--	2	--	--	4	2	10	20	A	0.4	2
15	*Cassia tora*	2	--	3	4	1	2	4	--	--	--	16	6	10	60	C	1.6	2.6
16	*C. occidentalis*	2	--	2	1	--	--	2	2	--	--	9	5	10	50	C	0.9	1.8
17	*Cleome aspera*	2	--	4	4	--	--	5	3	2	5	25	7	10	70	D	2.5	3.5
18	*Polygala chinensis*	2	--	--	3	--	--	--	--	--	--	5	2	10	20	A	0.5	2.5

S. No.	Name of the Species	Quadrats Laid Down										Total No. of Individuals of Species	Total No. of Quadrats of Occurrence	Total No. of Quadrats Studied	Frequency (%)	Frequency Class	Density	Abundance
		1	2	3	4	5	6	7	8	9	10							
19	*Peristrophe bicalyculata*	2	3	--	--	5	--	2	3	--	--	15	5	10	50	C	1.5	3
20	*Portulaca oleracea*	2	3	--	4	6	2	3	3	--	2	25	8	10	80	D	2.5	3.1
21	*Biophytum sensitivum*	--	--	--	2	--	--	2	--	1	--	5	3	10	30	B	0.5	1.6
22	*Gomphrena globasa*	--	--	--	3	--	--	--	--	--	--	3	1	10	10	A	0.3	3
23	*Oxalis corniculata*	--	--	--	2	--	--	--	--	--	--	2	1	10	10	A	0.2	2
24	*Clerodendrum inerme*	2	2	--	--	3	1	1	--	--	1	10	6	10	60	C	1	1.6
25	*Eriocloa procera*	--	2	3	1	2	--	--	2	2	1	13	7	10	70	D	1.3	1.8

To Prepare Frequency Diagram

Raunkiaer (1934) had classified various species into five frequency classes on the basis of their frequency values as follows:

Frequency (%)	Frequency Class
0-20	A
21-40	B
41-60	C
61-80	D
81-100	E

As shown in the Table 3, the total number of species recorded is 25, of which 7 belong to frequency class **A**, 5 to **B**, 4 to **C**, 4 to **D**, and 5 to **E**.

In terms of per cent, the value of A = $^{7}/_{25}$ x 100 = 28

B = $^{5}/_{25}$ x 100 = 20

C = $^{4}/_{25}$ x 100 = 16

D = $^{4}/_{25}$ x 100 = 16

E = $^{5}/_{25}$ x 100 = 20

Thus, the values of **A**=28%, **B**=20%, **C**=16%, **D**=16% and **E**=20%.

Take a graph sheet and plot the percentage frequency values on Y-axis against the five frequency classes on X-axis (Fig. 1.5).

The frequency diagram obtained (Fig. 1.5.) fulfils the Raunkaier's Law of Frequency classes (Fig. 1.4).

$$\begin{matrix} > \\ A > B > C = D < E \\ < \end{matrix}$$

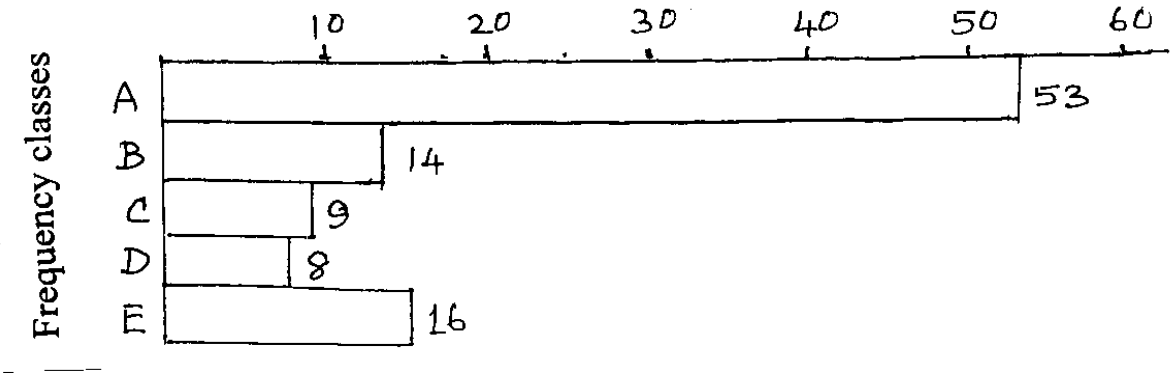

Fig. 1.4: Raunkaier's Normal Frequency Diagram

% of the total number of species

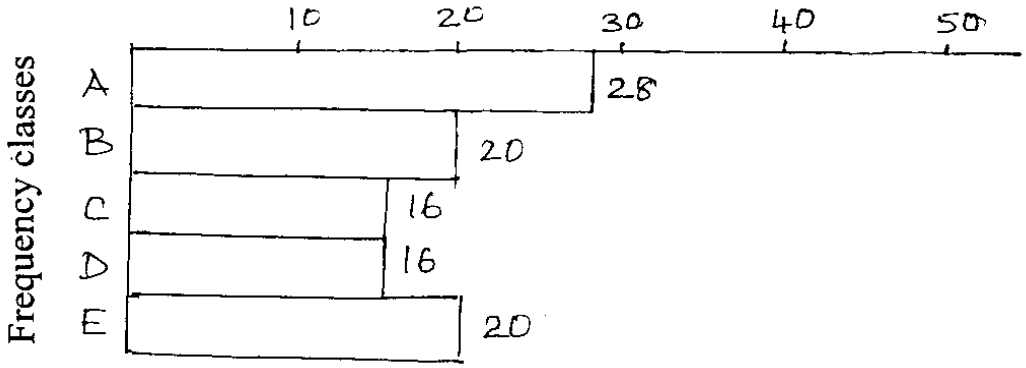

Fig. 1.5: Frequency Diagram of a Grassland Community

Discussion:

In general, when frequency classes B, C and D in the resulting frequency diagram are comparatively higher than the respective values in normal frequency diagram, the vegetation is heterogeneous. Higher the value of class E (as compared with the normal frequency diagram) greater will be the homogeneity in vegetation.

When we compare the frequency, diagram obtained (Fig. 1.5) for the area studied with the normal frequency diagram (Fig. 1.4), it is evident that frequency classes B, C and D in figure are comparatively higher than the value of respective frequency classes in Fig. 1.4. Thus, the community studied in the given area is heterogeneous.

EXERCISE-4

4) IMPORTANCE VALUE INDEX:

Aim: To determine the Importance Value Index (IVI) by quadrat method.

Requirements: One-meter metal quadrat, graph sheet, herbarium sheet and cello tape.

Procedure: Lay down the required number of quadrats (10 quadrats) randomly in the area to be studied. In each quadrat, note down the various species and also count the number of individuals of each species.

Observations and Calculations:

Field data should be tabulated as shown in Table 1.4. From this data, calculate the relative frequency, relative density and relative cover of different species (Table 1.5) present in the community as follows:

$$\text{Relative frequency of a species} = \frac{\text{Number of occurrence of a species}}{\text{Total number of occurrence of all species}} \times 100$$

$$\text{Relative density of a species} = \frac{\text{Number of individuals of the species in all quadrats}}{\text{Total number of individuals of all species in all quadrats}} \times 100$$

Cover is an expression of an area covered or occupied by different species. The cover may be studied both at the canopy level and at the ground level. The basal area is regarded as an index of dominance of a species. The higher the basal area, the greater is the dominance.

$$\text{Relative cover (Relative dominance)} = \frac{\text{Number of covers of the species in all quadrats}}{\text{Total number of covers of all species in all quadrats}} \times 100$$

CALCULATIONS

Relative Frequency (R.F.)

Total number of occurrences of all species in all quadrats = 55

$$\text{R.F. of } \textit{Abutilon indicum} = \frac{6}{55} \times 100 = 10.90$$

Relative Density (R.D.)

Total number of individuals of all species in all quadrats = 329

R.D. of *Abutilon indicum* = $\frac{65}{329}$ x 100 = 19.75

Relative Cover (R.C.)

Total number of covers of all species in all quadrats = 233

R.C. of *Abutilon indicum* = $\frac{21}{233}$ x 100 = 9.01

Table 1.4: Field Data on Density and Cover of Various Species

Species	I		II		III		IV		V		VI		VII		VIII		IX		X	
	D	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**
Abutilon indicum	8	4	7	3	--	--	7	4	--	--	5	4	--	--	3	2	5	4	--	--
Cleome aspera	5	3	4	3	4	3	--	--	--	--	6	4	--	--	8	6	5	3	--	--
Hybanthus enneaspermus	4	2	--	--	3	3	--	--	4	2	--	--	--	--	4	2	--	--	3	2
Portulaca oleracea	5	3	--	--	3	3	--	--	4	3	3	2	3	2	--	--	4	2	--	--
Sida acuta	8	4	--	--	7	3	5	3	--	--	6	4	7	4	--	--	6	3	--	--
Biophytum sensitivum	10	7	8	7	--	--	8	6	--	--	8	7	--	--	9	7	--	--	8	5
Alysicorpus monilifer	3	2	--	--	--	--	4	3	--	--	5	3	--	--	--	--	--	--	4	3
Clitoria ternatea	4	3	--	--	--	--	3	2	--	--	--	--	4	3	--	--	--	--	--	--
Indigofera trita	8	6	6	5	--	--	8	7	--	--	--	--	6	5	7	5	--	--	6	5
Asastitia gangetica	10	8	8	6	9	8	10	9	--	--	--	--	8	7	9	6	--	--	10	8
TOTAL	**65**	**42**	**33**	**24**	**26**	**20**	**45**	**34**	**8**	**5**	**33**	**24**	**28**	**21**	**40**	**28**	**20**	**12**	**31**	**23**

Table 1.5: Importance Value Index (IVI) of Various Species

Species	Relative frequency	Relative density	Relative cover	Importance Value Index (IVI)
Abutilon indicum	10.90	19.75	9.01	39.66
Cleome aspera	10.90	9.72	9.44	30.06
Hybanthes enneaspermus	9.09	5.47	4.72	19.28
Portulaca oleracea	10.90	6.68	6.43	24.01
Sida acuta	10.90	11.85	9.01	31.76
Biophytum sensitivum	10.90	15.50	16.73	43.13
Alysicorpus monilifer	7.27	4.86	4.72	16.85
Clitoria ternatea	5.45	3.34	3.86	12.65
Indigofera trita	10.90	12.46	14.16	37.52
Asastitia gantetica	12.72	19.45	22.31	54.48

Percentage values of relative frequency, relative density and relative cover of all species are calculated. In order to get the overall picture of ecological importance of a species with respect to the community structure, percentage values of relative frequency, relative density and relative cover are added together, and this value out of 300 is called the **Importance Value Index** (These values can be plotted on graph sheet (Fig. 1.6).

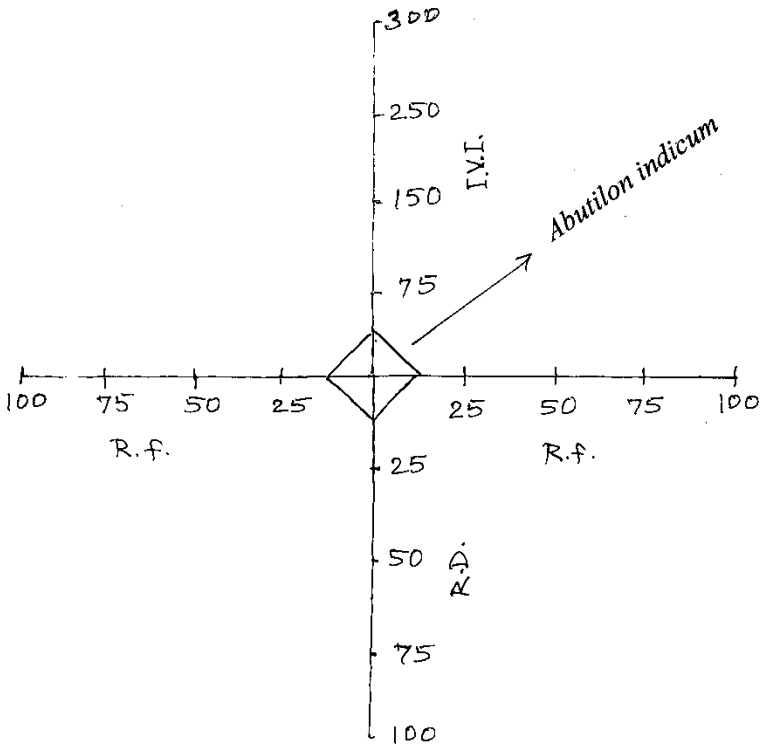

Fig. 1.6: Photograph shows Importance Value Index

EXERCISE-5

5) LINE TRANSECT METHOD:

Aim: The sampling unit in this case is a line of suitable length.

Objective: To study the vegetation by line transect method and determining the frequency of individual species.

Requirements: Measuring tape, graph sheet, herbarium sheet, cello tape.

Procedure:

Run the measuring tape across the vegetation. Note down the species touching the tape in alternate segments of suitable length (say 100 cm. long a shown in Fig. 1.7). A number of transects may be laid down at random across the field at different sites. Thus, in this case, one-meter long segment is the unit of study. If three plants of any species are touching the segment, the numerical strength of that species in that sampling unit (segment-1) will be three individuals. This value may be written against the respective species below that sampling unit.

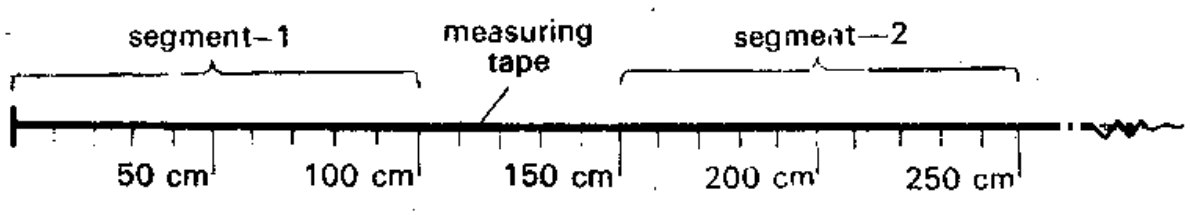

Fig. 1.7: Diagram showing a Part of the Line Transect (Measuring Tape) with 100 cm. Long Alternate Segments as Units of Study

Observations and Calculations: Tabulate the data as shown in Table 1.6.

Table 1.6: Species Recorded by Line Transect Method

Sl. No.	Name of the species	Segments Number 1 2 3 4 5 6 7 8 9 10	Total no. of segments in which the species has occurred	Total number of segments studied	Frequency (%)	Frequency class to which species belongs
1	*Cynodon dactylon*	+ + + + + + + + + +	10	10	100	E
2:20	*Dichanthium annulatum*	+ - - - - + + - - -	3	10	30	B

Calculate the percentage frequency of each species as done in quadrat method. Distribute the various species among five frequency classes, find out the percentage (of the total number of species) value of each frequency class, and prepare frequency diagram, similarly as done in quadrant method. Compare the frequency diagram with the normal frequency diagram to draw possible conclusions.

Density values of individual species may also be determined. In each segment, also note down the total number of individuals of each species touching the segment.

Conclusions:

Name the two most frequency species, and find out whether the vegetation is homogeneous or heterogeneous in the way as explained in quadrat method.

EXERCISE-6

6) POINT-FRAME METHOD:

In this case, the sampling unit is a point. A point-frame (as shown in Fig. 1.8) is a sample, about 50 cm. long and 50 cm. high wooden frame in which there are inserted 10 movable pins (each about 50 cm. long) at 45^o angle.

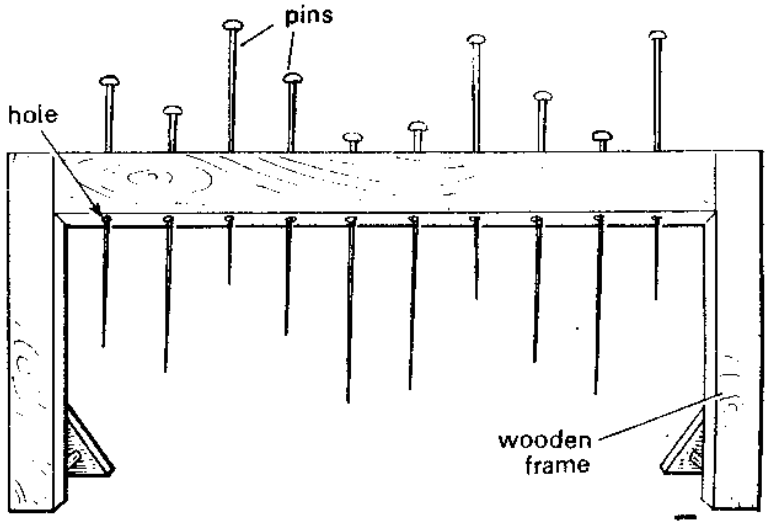

Fig. 1.8: Diagram showing the point-frame apparatus

Objective: To study the vegetation by point-frame method, determining the frequency of each species present in the field.

Requirements: Point-frame apparatus, graph sheet, herbarium sheet, cello tape.

Procedure:

The apparatus with 10 pins puts at a place is one sampling unit. Put the apparatus at random at a number of places (20 or more) in the field and note down each time the various species hit by one or more of the 10 pins. Thus, pin is one sampling unit. If five plants of any species touch five pins in one sampling unit put at a place, the numerical strength of that species in that sampling unit will be five individuals. This value may be written against the species below that sampling unit.

Observations and Calculations: Tabulate the data as shown in Table 1.7.

Table 1.7: Species Recorded by Point Frame Method

Sl. No.	Name of the Species	Number of Places where Apparatus is put 1 2 3 4 5 6 7 8 9 10	Total No. of places at which occurred	Total number of segments studied	Frequency (%)	Frequency class to which species belongs
1	*Cynodon dactylon*	+ + + + + + + + + +	10	10	100	E
2:20	*Dichanthium annulatum*	+ - - + + + - - + +	6	10	60	C

Calculate the percentage of each species as done in quadrat method. Distribute the various species among five frequency classes, find out the percentage (of the total number of species) value of each frequency class, and prepare frequency diagram similarly as done in quadrat method. Compare the frequency diagram with the normal frequency diagram to draw possible conclusions.

Conclusions:

Name the two most frequent species and find out whether the vegetation is homogeneous or heterogeneous in the way as explained in quadrat method.

Density values of individual species may also be determined. At each place, also note the total number of individuals of each species being hit by 10 pins.

EXERCISE-7

7) DETERMINATION OF DUST FALL RATES:

Object: To determine the dust fall rate from different polluted areas.

Dust-fall measurements provide a rough estimation of atmospheric pollution. The **trap method** given here has a sensitivity up to 0.2g/m^2/month. **Dust-traps** are exposed to atmosphere for certain period and the collected soil is weighed. The traps can be kept on roof-top in various areas as **industrial, residential, commercial, highways** etc. It is kept at least 3 meter above the ground level. A line drawn from the trap to the nearest point of the highest edge of any building should not form more than a 30^o angle with the horizontal. A minimum of one-month sampling period is required.

A dust-trap is a large polythene container with a tapered cylinder and a sealable lid, the diameter of which should not be less than 15 cm and the height 2 or 3 times of it. A suitable guard frame should also be provided. Sieves no. 18 or 20 are also required. Distilled water is filled in the traps at least up to the half level. Some algicide or fungicide should be added to the trap. Traps are exposed to atmosphere. After the expiry period, the lid is put and they are brought to laboratory. Dust can be weighed. The sample is screened through sieve to remove extra material. The filtrate is weighed (i.e. water insoluble fraction). Supernatant is also evaporated to retrieve the insoluble portion. These weights are combined to get total weight of the dust and calculations are made as follows:

$$\text{Dust-fall rate} = \frac{w}{a} \times \frac{30}{t}$$

where dust-fall is as g/m^2/month

w = weight of the dust obtained

a = open area of sampling container at the top;

t = days of exposure

The dust can also be collected in open buckets or on sticky tape wrapped around jars.

EXERCISE-8

8) TOTAL SOLIDS AND TOTAL DISSOLVED SOLIDS IN WATER SAMPLE

Object: To determine the **pH, total solids** and **total dissolved solids** in a given water sample.

Procedure: Total solids can be measured as the residue left after evaporation of the unfiltered sample. Take an evaporating dish, or crucible or beaker and weigh it. Put 250-500 ml of unfiltered well shaken water sample in it and evaporate on a water bath. After evaporation, dry it in an oven at 105^{o}C for 1 hr., cool it in dessicator and take final weight.

$$\text{Total solids (TS) in mg/l} = \frac{(a-b) \times 1000 \times 1000}{V}$$

a = final weight of the container with sample (g)

b = initial weight of the container (g)

V = volume of the sample evaporated (ml)

Total Dissolved Solids (TDS) denote mainly the various kinds of minerals present in the water sample. They do not contain any gageous or colloidal fraction. They can be measured as the residue left after evaporation of the filtered sample. Take an evaporating dish and weigh it. Filter the water sample through Whatman filter paper. Take this clear filtrate in the container and evaporate on a water bath. Later dry it in oven at 105^{o}C for 1 hr. cool it in a dessicator and take final weight.

$$\text{TDS in mg/l} = \frac{(a-b) \times 1000 \times 1000}{V}$$

a = final weight of the container (g)

b = initial weight of the container (g)

V = volume of the sample evaporated (ml)

For the **pH value** of pond water, collect sample during different months of the season, and from different places and depths of the pond. From each sample take few ml of water in a test tube and add to it few drops of universal indicator. Compare the colour developed with the colour chart to find out the approximate pH value of the water sample.