THE PLANT ECOLOGY & FIELD COURSE

PLS317: Plant Ecology & Field Course

Oyesiku O.O. PhD.
Department of Plant Science
Olabisi Onabanjo University, Ago-Iwoye Nigeria

The EcoBryologist

Course Outline

Lecture-1. Selection of Sampling Techniques in Local (4 wks) OOU-BIOME [*Students to submit report for grading*] s)

Lecture-2. Modern Concepts in Ecology (1 Wk)

Lecture-3. Concepts of Population (1 Wk)

Lecture-4. Concepts of Succession (1 Wk)

Lecture-5. Relationship between Plants and Topography (1 Wk)

Lecture-6. Relationship between Plants and Soils (1 Wk)

Sampling Technique in Local Habitat

Problem

It is impossible to count population of every one species (plant and animal) present in a given habitat

- **A suitable sampling technique will solve this problem**
  - **know what kind of plants and animals are in a given habitat**
  - **Make checklist of species in the habitat**
- **Step-by-step technique to sample species in a local habitat**
  - **Pre-survey of the habitat for representative sample**
  - **Selection of suitable sampling techniques**
  - **Assumption of selection and sample size to be used**
  - **Adopt a standard sampling units for determining sample size of representative species**

Standard sampling units

- Quadrat unit (square, rectangular, triangular, circular frames)
  - A universal standard unit of sampling
  - compare samples obtained from area of fairly uniform size and shape (**warning**: data obtained from two different quadrat shape will introduce variation in the results obtained)
- Other sampling units
  - Standard bottle/container: to study water contamination in local habitat
  - Snail (similar size/shape): to study algae diversity on snail shells
  - Leaves (similar size/shape): to study diversity of bryophytes on leaf surface

Methods of Sampling in Local Habitat

Three Methods of Sampling

1. **Random method**
2. **Systematic method**
3. **Stratified method**

Random Sampling Technique

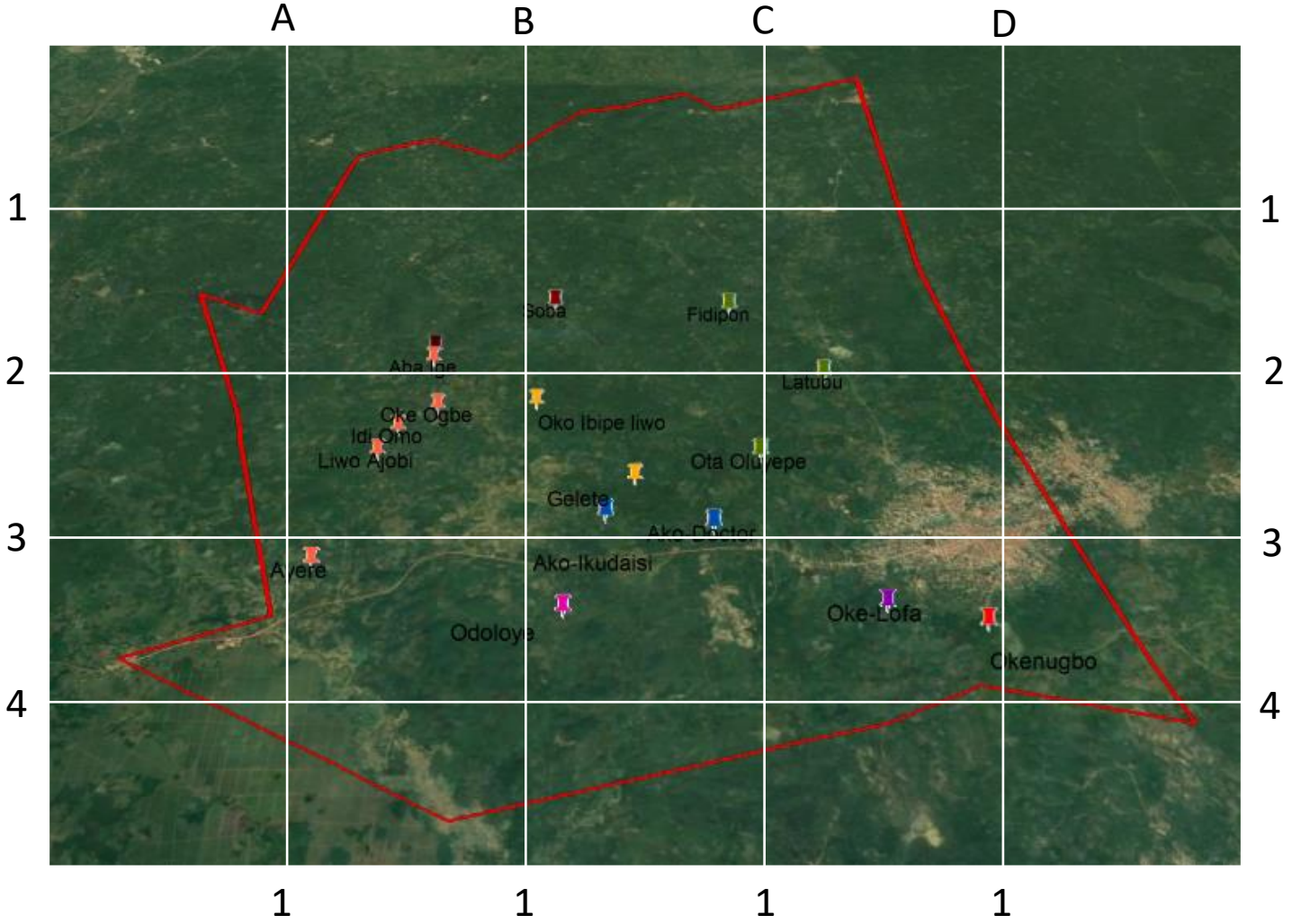
Criteria

- ❑ Select fairly uniform habitat for study
- ❑ Large sampling size (no of samples) is required
- ❑ A quadrat frame unit is required
- ❑ Quadrat size must be 2 to 10 folds of target species

Criteria (cont)

- ❑Map out and grid study area
- ❑Use numbered grids to locate sample quadrat
- ❑Use random number table to select quadrat to sample

Grid map of study area in Ago-Iwoye



Random Number Table

(Statistics for Biologists by R.C. Campbell, Cambridge University Press, 1974)

20	15	09	03	11	67	45	24	02	18
24	04	04	07	08	23	02	26	26	12
14	10	11	09	17	18	06	71	15	04
22	16	15	03	05	02	18	69	12	05
11	50	76	17	06	08	50	90	14	19
45	07	02	18	45	24	09	03	20	15
44	19	26	12	02	26	04	07	24	04
35	01	15	04	06	71	11	09	14	10
64	23	12	05	18	69	15	03	22	16
03	11	14	19	50	90	76	17	11	50

Systematic Sampling Techniques 1

1. Line Transect Method

Criteria:

- Habitat must shows zonation of species along a slope or valley gradient
- Sample should be taken at a fixed interval along a line
- Examples:
  - up a river bank or across a woodland edge (gradient)
  - From a pollution source (continuous variation)
  - Roadside cut, cliff, vertical rock surface, tree trunk (linear)

Systematic Sampling Techniques 2

2. Belt Transect Method

Criteria:

- Must provide information on species richness, diversity, relative abundance and cover
- Calculate total percentage cover of species in a single quadrat (note: frequently add up to more than 100%)

Line Transect Method

Step-by-step procedure

- Use a nylon rope marked and numbered at intervals (0.5 m or 1m) along its length
- Fix the transect line across the area (gradient) to be study
- Record the species (present/absent) at the marked interval points
  - continuous sampling or
  - at constant interval points

Belt Transect Method

Step-by-step procedure

- Place quadrat on the marked points along a line transect at
  1. All the point interval on the line transect
  2. predetermined points only
  3. Random points (even or odd)

- Identify and estimate relative abundance and cover of species found inside the quadrat

Caution!

1. Sampling should always be as least destructive as possible
2. Avoid too much trampling on the sampling area

Stratified Sampling Technique

Criteria

- ❑Avoid missing out an important area of the study habitat by
- ❑Dividing the study area into strata based on
- ❑Physical factors that aids the species distribution in the habitat

Step-by-step procedure

- ❑Identify different areas within the main habitat
- ❑Sample each individual area separately
- ❑Estimate the proportional area of each individual stratum in relation to the total habitat area

Stratified Sampling Method

Step-by-step procedure

- ❑Identify different areas within the main habitat
- ❑Sample each individual area (stratum) separately
- ❑Estimate the proportional area of each individual stratum in relation to the total habitat area

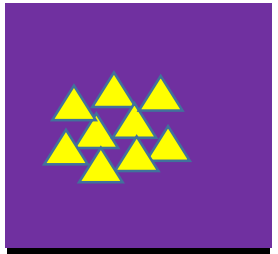
Nearest Neighbour Analysis (Rn)

Nearest Neighbour Analysis (Rn) is a technique used to detect pattern of distribution of species in a habitat

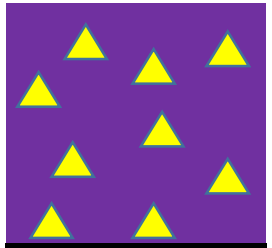
Nearest Neighbour Analysis (Rn)

Criteria

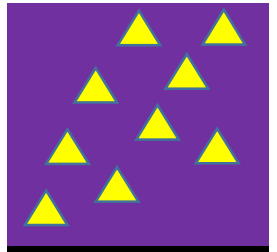
- The distribution of patterns of species must be continuum
- Examples: Cluster, random or regular



Cluster
Rn=0



Random
Rn=1



Regular
Rn=2.15

Objectives of Nearest Neighbour Analysis

- To test whether a vegetation is clustered, random or regular
- To test the hypothesis that OOU-BIOME vegetation forms the climax community (Rn=1)
- To test If trees distribution is of regular pattern (Rn=2.15) i.e. plantation)

Step-by-step procedure 1

- Select an area of woodland in the OOU-BIOME using random numbers table
- mark out a 50 m X 50 m (2,500 m^2) quadrat (sufficient to obtain a minimum number of 30 trees)

Step-by-step procedure 2

- **Measure the distance of each tree within the quadrat to its nearest neighbour as illustrated below**

Field Activity

Data Sheet

TreeNo.	Dist to nearest neighbour (m)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Formula & Calculation

$$Rn = \frac{\overline{D}_{obs}}{0.5\sqrt{\frac{a}{n}}}$$

Where:

Rn = Nearest Neighbour Value

$\overline{D}_{obs}$ **= mean observed nearest neighbor distance**

a = area under study

n = total no. of points

Interpretation of *Rn*-value

- ***Rn*** **= 0 represents clustered pattern of vegetation**
- ***Rn*** **= 1.0 represents random pattern of vegetation**
- ***Rn*** **= 2.15 represents regular pattern of vegetation**



THE END OF LECTURE

Modern Concepts in Ecology

Introduction

To resolve man's environmental crisis there is need for the framework of successional theory to be examine

The principles of ecological succession rest on the relationships between man and nature

Modern Concepts in Ecology

Concepts views

- Clement’s universal law approach (1916)
- Odum’s orderly process approach (1969)
- Lindeman’s trophic-dynamic approach (1942)
- Landscape ecology
- Landscape ecotype pattern

Lecture 2

Clément's universal law approach (1916)

- Succession is a basic concept or theory of universal law which states that
  - all bare places give rise to new communities except
  - bare places in extreme conditions
    - waterlogged
    - temperature
    - light
    - soil

Lecture 2

Odum's orderly process approach (1969)

Succession is an orderly process that is directional and predictable resulting from

- modification of physical environment by the communities control given to
- A stablised (climax) ecosystem with
- Connection and unity of structure and process

Lecture 2

Lindeman's trophic-dynamic approach (1942)

Succession is the process of development in an ecosystem primarily by the effects of

- organisms on the environment and themselves
- leading to a stable condition of equilibrium called
- Trophic-dynamic equilibrium

Lecture 2

Landscape ecology

- Landscape include terrestrial and aquatic ecosystems but ends at seascape (seashore)
- Landscapes are restricted to atmosphere-lithosphere interface

Lecture 2

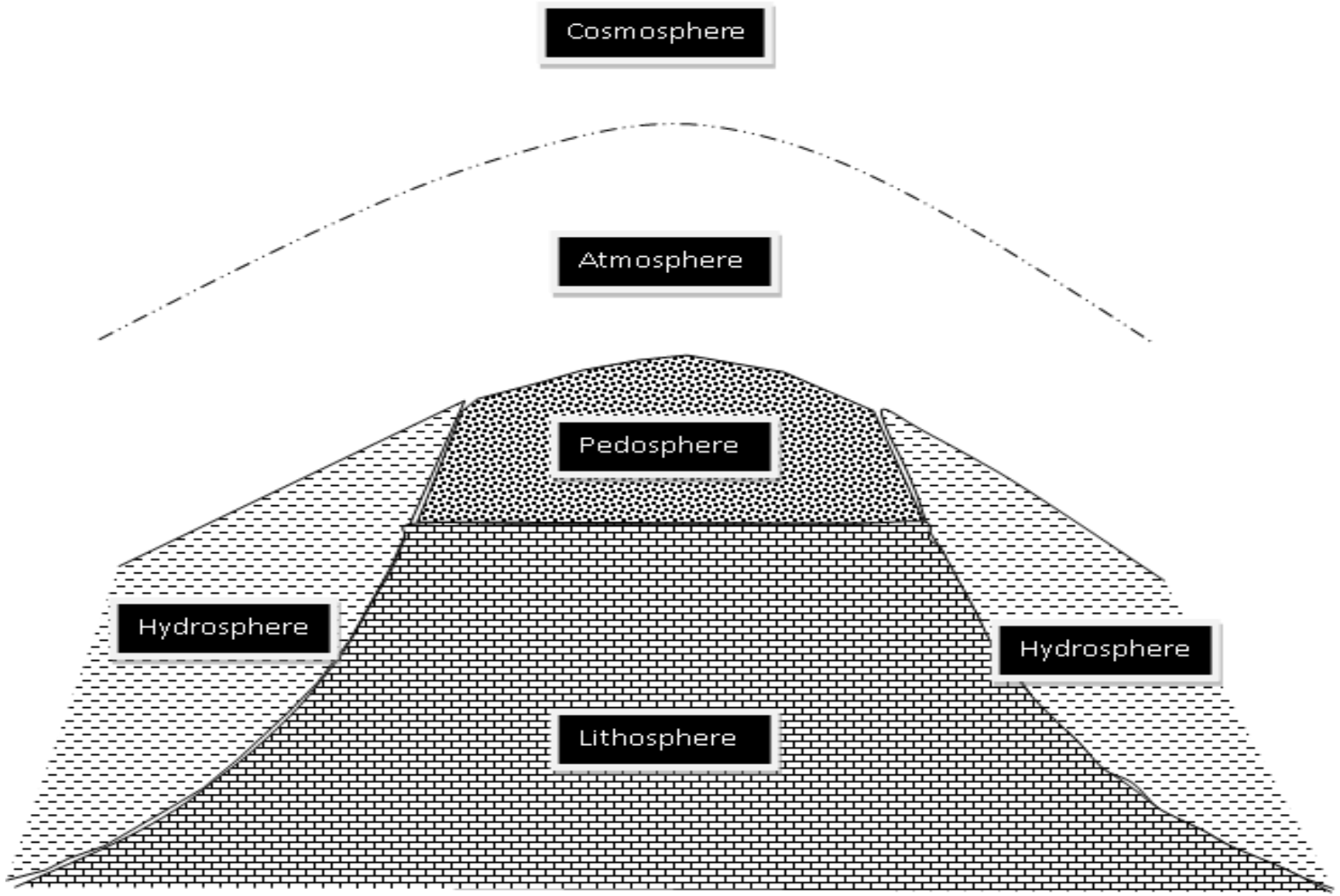
Landscape ecology

- Landscape ecology deals with the assemblages of ecosystems occurring in a geographical defined region

- Ecosystem ecology deals with groups of plant and animal and their abiotic environment at a given location

(Haber 1989)

Environmental Spheres



(after Van Leeuwen 1985)

Hierachical order of environmental sphere

Sphere	Properties	Example
Abiotic		
Cosmosphere	Cosmic life-supporting agent	Solar energy and gravitation
Atmosphere	Gaseous life-supporting conditions	Weather and climate
Hydrosphere	Liquid life-supporting medium	water
Lithosphere	Solid life-supporting matter	Basement rocks
Biotic		
Biosphere	Organisms	Plant and animal
Pedosphere	Interaction of lithosphere and biosphere	Soil and decomposition

THE END

Lecture 3

Concepts of Population

Population ecology (autecology)

- study of the **processes** that affect the distribution and abundance of animal and plant populations.
- the geographic boundaries of a population are easy to establish for some species but more difficult for others

Lecture 3

Types of population

- *r*-selected strategy
  - opportunistic because their reproductive behaviour involves
    - a high intrinsic rate of growth (*r*)
    - individuals give birth to many offspring at a juvenile age
    - because of uncertain environment
  - mortality occurs randomly in this setting
    - quantity of progeny rather than quality of care serves the species better

Lecture 3

- *K*-selected strategy
  - Remain near the carrying capacity (K)
  - Individuals give birth at a mature age to fewer progeny
  - Exhibited in more stable environment
  - Reproductive success depends on fitness of the progeny than on their numbers

Lecture 3

Density-dependent factors vs Density-independent factors

Density dependent factors

- regulate the population in proportion to its density by aid of
  - competition
  - predation and
  - diseases

Lecture 3

- It usually operates in a large population and causes
- the population either to increase or decrease
- depending on how it affects the ecosystem

Lecture 3

For example

- huge population can deplete the resources of an area and cause
- shortage leading to hunger and death
- eventually cause the reduction in the population

Lecture 3

Density independent factors

- regulate the population without considering its density
- by natural disasters and the weather
- it operates in both large and small populations and
- it is not based on population density

THE END

Lecture 4

Succession

Lecture 4

Concept of Succession

- Succession is the natural, orderly change in plant and animal communities that occur over time
- If left undisturbed for 150-300 years it becomes climax
- Edaphic condition, climate, topography may affect the pattern of succession

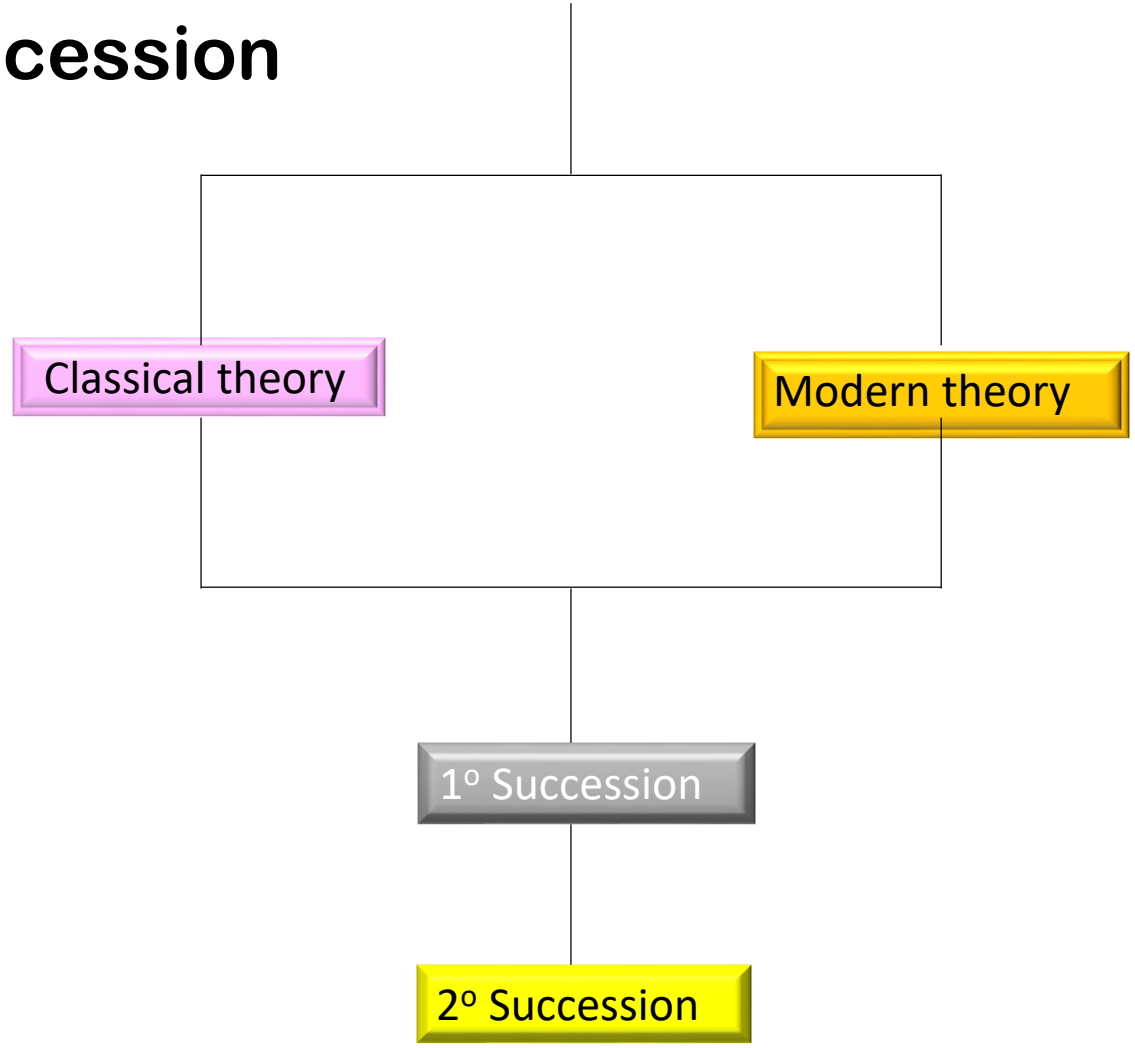
Lecture 4

Concept of Succession

- Succession is the natural, orderly change in plant and animal communities that occur over time
- If left undisturbed for 150-300 years it becomes climax
- Edaphic condition, climate, topography may affect the pattern of succession

Lecture 4

Concepts of succession



Lecture 4

Characteristics

- Classical theory of succession is based on man made disturbance
- Modern theory is based on natural disturbance
- Primary succession begins with the
  - geophysical processes while
- Secondary succession starts
  - after man made disturbance

Lecture 4

1. Classical concept of succession

- The classical plant succession theory suggests that once the climatic climax vegetation is reached then the community remains in a steady state
- This monoclimax concept was invented by the American ecologist F.E. Clements (1916)
- It is believed that it was climate alone that determined the final vegetation outlook

Lecture 4

The different between the Clements and Tansley theory

- ❑ is the time needed for the growing vegetation to reach stable community (climax)
- ❑If enough time is given, the edaphic and other climaxes will be overtaken and a single climatic climax community would be achieved
- ❑the monoclimax theory allows one climatic climax in a region and the polyclimax theory allows several climaxes in the same area

Lecture 4

3. Climax Pattern Theory

The climax pattern hypothesis state that there is a continuity instead of discrete climax types along environmental gradients

Whitaker (1963). McIntosh (1958) and Sellech (1913)

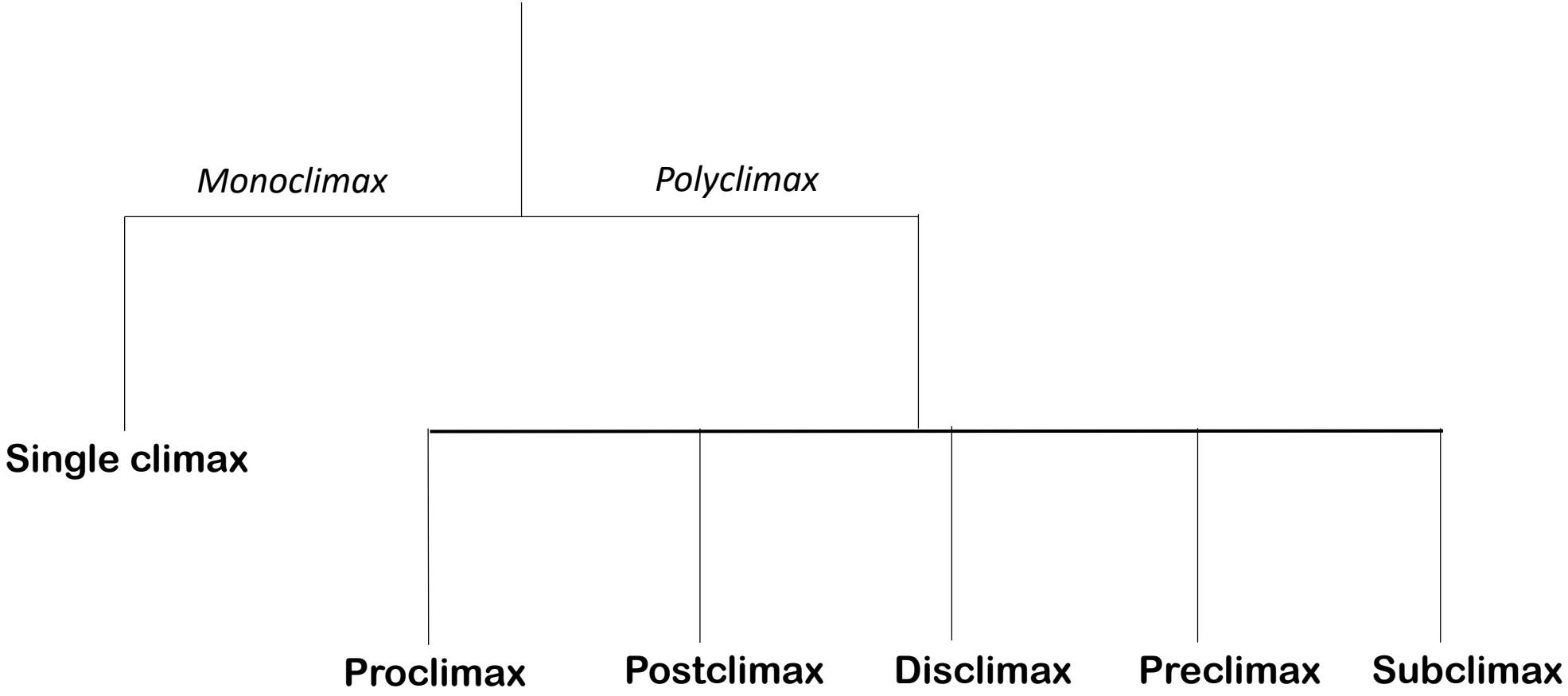
Lecture 4

Three theories of succession climax communities

1. Monoclimax theory
2. Polyclimax theory
3. Climax pattern theory

Lecture 4

1. Climax Theories



(Frederick Clements in 1916)

Characteristics

Monoclimax

- ❑ **Single climax is a stable community determined by climate zones**

Polyclimax

- ❑ **Proclimax community is more or less stable similar to climax**
- ❑ **Disclimax community is disturbed by man and animals (grassland in forest zone)**
- ❑ **Preclimax or subclimax community development is terminated by cutting, burning, grazing and flooding**
- ❑ **Postclimax community is a strip of vegetation within the climax (forest strip along a stream in grassland)**

Lecture 4

Other types of climax vegetation (short-lived) are:

- plagioclimax subclimax (after deforestation, ploughing, burning)
- Biotic subclimax (man-generated)
  - Disclimax (disturbance climax)
  - Anthropogenic subclimax (man-generated)
- Edaphic subclimax (soil factors)

Lecture 4

Other types of climax vegetation (short-lived) are:

- plagioclimax subclimax
- Biotic subclimax
- Edaphic subclimax

Lecture 4

- Plagioclimax subclimax

Examples

- Deforestation
- Ploughing
- Burning

Lecture 4

Types of Succession

- Primary
- Secondary
- Allogenic
- Autogenic
- Progressive
- Retrogressive

3. Primary succession

- Primary succession is initiated on bare inorganic surface (non-vegetated surface)
- Primary succession is a natural interruptions that ignite the process of vegetation development

Lecture 4

Secondary Succession

- Establishment of plants on land was previously vegetated
- Caused by nature or human
  - Examples
    - fire
    - logging
    - cultivation
    - floods

Lecture 4

Allogenic Succession (exogenous)

- The environmental changes caused the changes in composition of a plant community
- Allogenic success is driven by periodic disturbances
- Example: Swamp to woodland

Lecture 4

Autogenic Succession (endogenous)

- Plants activities over time cause change in both plant community and environment
- Example: primary succession initiated the development of soils from bare surface

Lecture 4

Progressive Succession

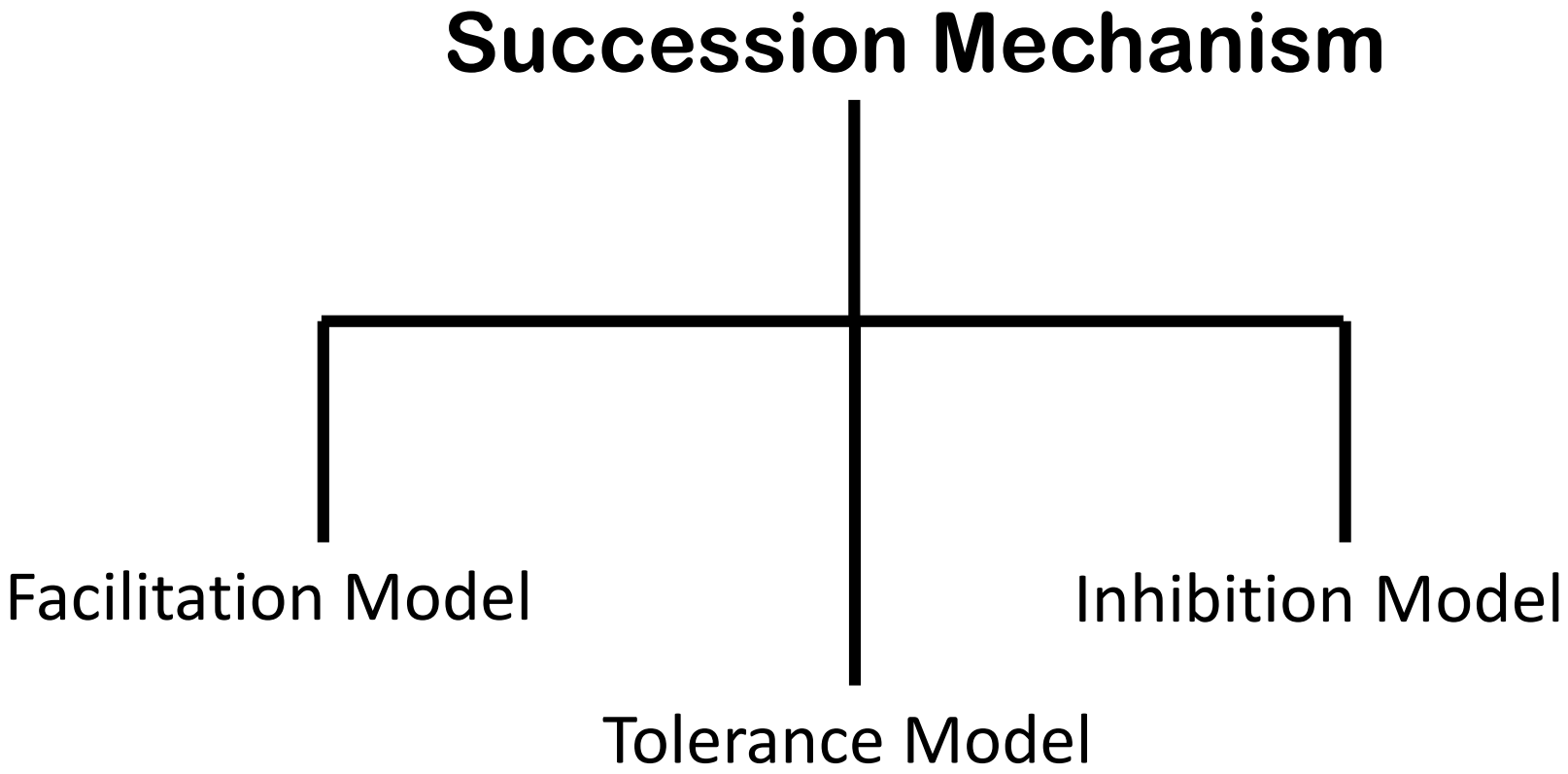
- Where community becomes complex with time
- Contain high diversity of species over time

Lecture 4

Retrogressive Succession

- When a community simple with low diversity of species
- It is caused by natural or human disturbance
- Example: grazing practice in farmland

Lecture 4


Succession Mechanism
Facilitation Model
Tolerance Model
Inhibition Model

Lecture 4

The Facilitation Model

- Pioneer species establish on the disturbed sites
- They modify the site making it suitable for invasive species
- The invasive species displace the pioneers
- This process repeat itself many times until climax stage is reached

The Tolerance Model

- All species in succession independently establishing themselves on recently disturbed sites
- The fast growing species becomes dominant
- This model is similar to natural selection

The Inhibition Model

- All spp. have equal chance to establish themselves after a disturbance
- Some dominant spp. make the site less suitable for establishment of other spp.
- A plant may secrete toxins in the soil preventing establishment of other plants

The End of Lecture

Lecture 5

Relationship between Plants and Topography

Lecture 5

- The abiotic factors that affect plant growth and development include edaphic, climatic and topographic factors
- Topography refers to the land form such as
- the land elevation, slope, slope aspect, shape, terrain (flat, rolling, hilly), mountain ranges and bodies of water
- The slope (inclination) is measured in percentage
  - by dividing vertical distance interval by horizontal interval distance multiplied by 100
  - A 45^{O} angle of elevation is equivalent to 100% slope

Lecture 5

Slope steepness versus plant growth

- Steep slope causes
  - differential incidence of solar radiation
  - Changing in wind velocity
  - Varying soil types
  - Soil degradation (surface runoff and erosion)

Lecture 5

Altitude versus Plant growth

- Altitude (elevation) is the vertical rise from the sea surface level into the sky
- Temperature decreases by 1 ^{o}C for every 100 m increase in altitude in dry air [Stiling, 1999]
  - Causing changes in plant communities with increasingaltitude

Lecture 5

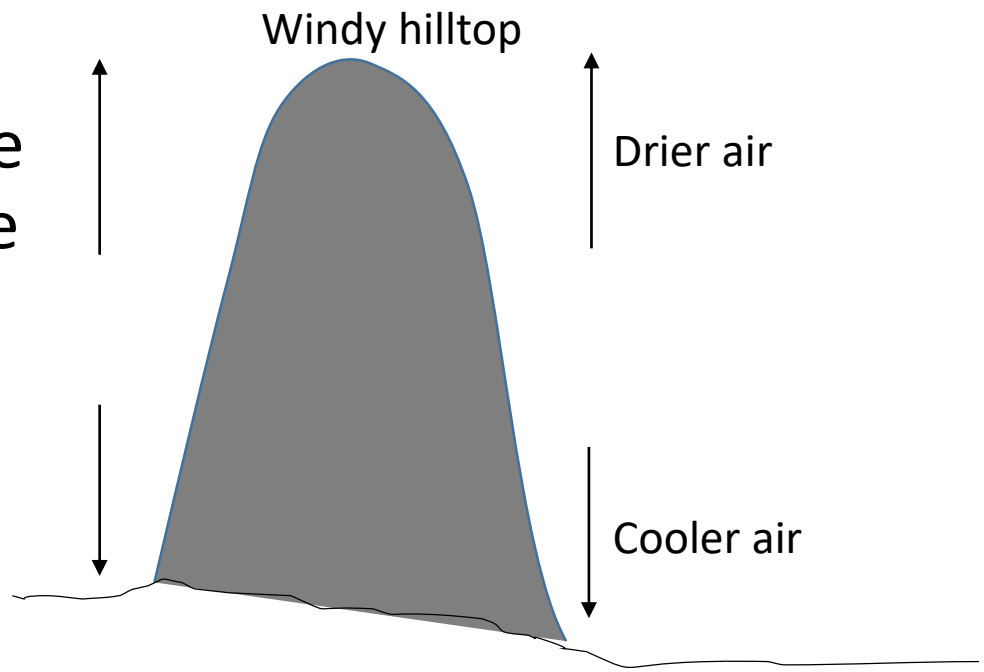
Topography versus Microclimates

- Topography create differences in climate over a small distances
- The differences in
  - temperature
  - moisture
  - exposure to light
  - exposure to wind
- These differences create microclimates
- That are indicators of many natural communities

Lecture 5

For example:

- Higher evapo-transpiration takes place on the ridge than sheltered base of the hill
- Only plants that can tolerate windy and drier conditions dominate the ridge
- Only plants that prefer less windy and more moist conditions dominate the base of the hill

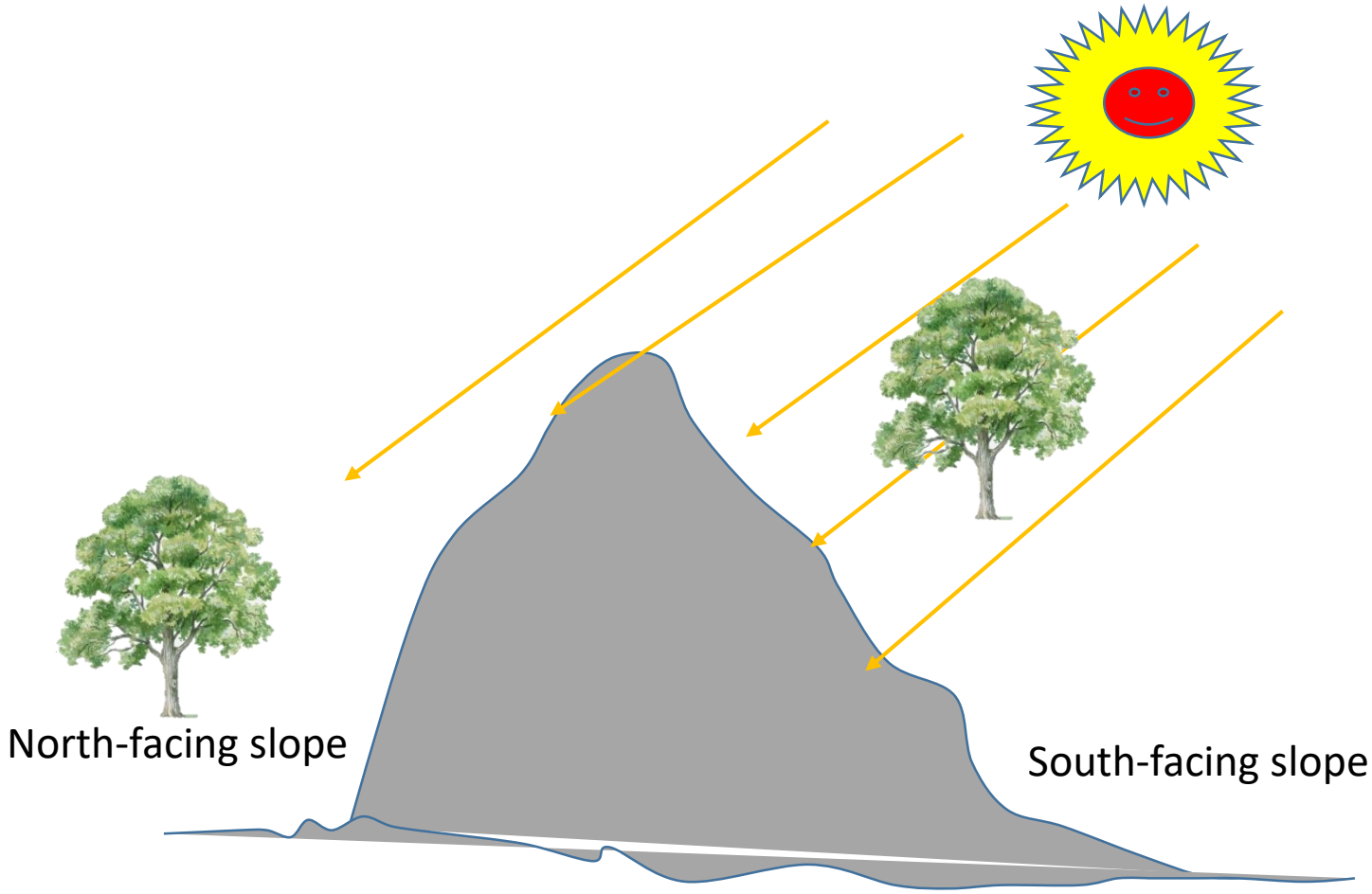


Lecture 5

South-facing and North-facing Slopes

- South-facing slope
  - In the northern hemisphere the south-facing slope receive sun and dry air than nearby north-facing slopes
  - The sunlight strike a south-facing slopes directly than they strike a north-facing slope
  - This explains
    - Why snow melts away faster on south-facing slope than on the north-facing ones
    - Plants with adaptations to warmer temperature, sunny and drier conditions prefer south-facing slopes
    - Those plants adapted to more shade, moist and cooler temperatures dominate north-facing slopes

Lecture 5



Lecture 5

Slope shape versus Plant growth

- Convex slopes have dry, infertile and shallow soil that make it difficult for growth of many plants
- Concave slopes have deep, moist, fertile soils that support diversity of plants species

Lecture 5

Recommended altitude for growth of selected plants

Crop	**Altitude (meters above sea level - masl)**
Coco nucifera (coconut)	≤ 600 masl (PCARRD, 1982)
Camellia sinensis (Tea)	≥ 1000 masl (Abellanosa & Pava 1987)
Hevea brasiliensis (Para rubber)	≤ 500 masl (Abellanosa & Pava 1987)

Lecture 5

REFERENCES

ABELLANOSA AL, PAVA HM. 1987. Introduction to Crop Science. CMU, Musuan, Bukidnon: Publications Office. p. 23-64.

(PCARRD) PHILIPPINE COUNCIL FOR AGRICULTURE AND RESOURCES RESEARCH AND DEVELOPMENT. 1983. The Philippines Recommends for Coconut. 89 p.