BIOL 353 PRINCIPLES OF ECOLOGY II

3 CREDIT HOURS

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COURSE OBJECTIVES

- To provide students with an in-depth knowledge of plant distribution and factors affecting it.
- To introduce students to basics and concepts of biogeography, and the factors responsible for biogeographic patterns.
- To introduce students to the various biomes of the world.
- To provide students with the knowledge about forest management and climate change.
- To provide students with the knowledge of ecological succession.

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LEARNING OBJECTIVES

- Students should be able to describe and account for plant distribution.

- Students should be able to explain the concepts of biogeography and account for biogeographic patterns in the world.

- Students must be able to fully describe the various biomes of the world, and indicate the factors differentiating one biome from another.

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LEARNING OBJECTIVES Cont'd.

- Students must be able to explain forest management, describe the types of forest management systems and explain how each of them affects climate change.

- Students should be able to explain ecological succession, mention and describe the types of succession, and describe the factors controlling succession.

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Course contents

- Vegetation development
- Distribution of plant and animal species (global)
- Island biogeography
- Major biomes of the world (e.g. Tundra, Taiga, Forest, Savanna, Desert)
- Forest management and climate change
- Plant community organization
- Determination of plant densities and frequencies
- Succession

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Recommended text books and websites

- Cunningham Saigo. 1997. Environmental Science: a global concern. Fourth Edition.
- Fred Van Dyke.2003. Conservation Biology: foundations, concepts, application. McGraw-Hill Company Inc.
- Manuel C. Molles Jr. 1999. Ecology: concepts and applications. McGraw-Hill Company Inc.
- Gutierrez, Kenneth, Marlon Amador, Eli Gonzalez, and Stephanie M. Tropical dry forest biome." *tropical dry forest biome*. N.p., n.d. Web. 15 oct. 2013. http://www.slideshare.net/mdonohue/tropical-dry-forest biome.
- Leo Robert Smith. 1990. Ecology and Field Biology.
- Bush Mark B.2003. Ecology of a changing planet. Third Edition.

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GENERAL COMMENTS

- Lateness to class will not be entertained under any circumstances.

- Mobile phones MUST either be switched off or be put in silent mode during the entire period of a lecturer. If a phone rings to cause a distraction, it will be confiscated.

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GENERAL COMMENTS

- It is compulsory to attend lectures. Failure to do so could render you ineligible to write the exams for this course.

- All forms of noise during lecturers should be avoided.

- No form of indecent dressing would be allowed in my lectures; examples include exposure of private body parts, wearing of bathroom slippers, vest, tattered jeans etc., and failure to tuck in.

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GENERAL COMMENTS

- Breach of any of the above listed rules would result in your expulsion from my class

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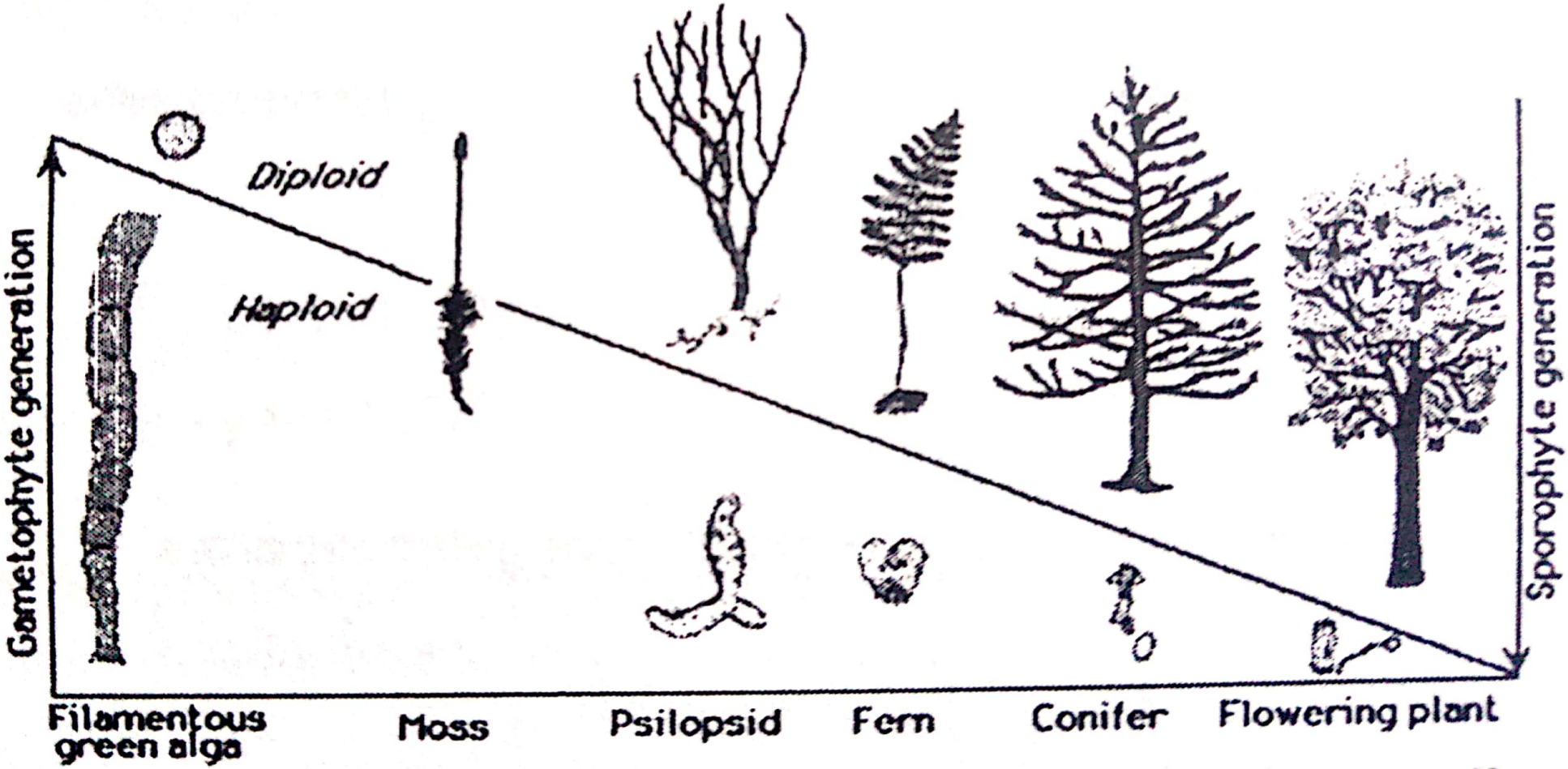
Vegetation Development

- It is believed that different groups of plants evolved at different eras and periods of major geographical events.



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Vegetation Development Cont'd.

- Terrestrial plants are believed to have evolved from a class of freshwater green algae called the charophyte.

- This assumption is based on a number of similarities between charophytes and the earliest land plants (bryophytes).

- For instance, two orders of charophyte namely, Coleochaetales and Charales resemble bryophytes in diverse ways.

- E.g. they show similarities in chloroplast and sperm cell structure, and patterns of cell division during mitosis.

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Vegetation Development Cont'd.

- It is believed that larger and more complex seedless plant groups emerged and dominated terrestrial habitats later. They include:

Lycophyta	Sphenophyta	Pteridophyta

- Although the three phyla are believed to have been common in the past, only the Pteridophytes (ferns) are common today.

- The dominance of the above-mentioned plant groups was reduced, and they were replaced by gymnosperms (seed plants) which dominated for about 200 million years.

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Vegetation Development Cont'd.

- Gymnosperms declined in dominance and were replaced by angiosperms.

- Currently, conifers are the most abundant gymnosperms on Earth.

- Angiosperms have been the most diverse and widespread group of plants on Earth till now.

- They are thought to have evolved from gymnosperms.

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Vegetation Development Cont'd.

Adaptations that enabled water plants to move unto land

- **Stronger stems and roots**
- **Tough cell walls**
- **Vascular system**

Further adaptations in early gymnosperms

- **Seeds with thick, resilient outer coat.**
- **Evolution of pollen grains.**

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Vegetation Development Cont'd.

Further adaptations in early angiosperms

- More efficient vascular tissues.
- Embryos protected by a seed coat.
- Developed ovary (fruit) which houses and protects the ovules (seeds).
- Leaves had various features to resist desiccation.
- More efficient pollination due to possession of flowers.
- Effective seed dispersal due to possession of fruits.

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Biogeography

- Biogeography is the study of the geographical distribution, both past and present, of plants, animals and other organisms.

- Various parts of the world are separated by geographic barriers such as oceans, mountain ranges, distances, etc.

- These areas have unique vegetation types, and therefore they are delimited into various biogeographic regions based on their vegetation types.

- Is there any significance of geographic separation?

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Biogeography

- Biogeography determines where organisms live, at what abundance, and why.

QUESTIONS

- How are organisms adapted to their local environments?

- How do the distributions of organisms change with time?

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E.g. 1. Why do the tropics harbour higher biodiversity than other parts of the world?

E.g. 2. Why is Ghana's liana flora different from Malaysian liana flora?

Goals of biogeography

- To provide baseline information on the spatial and temporal distribution of organisms in order to conserve and manage the Earth's biotic resources and heritage.

- To determine biogeographic processes that account for biotic distributions.

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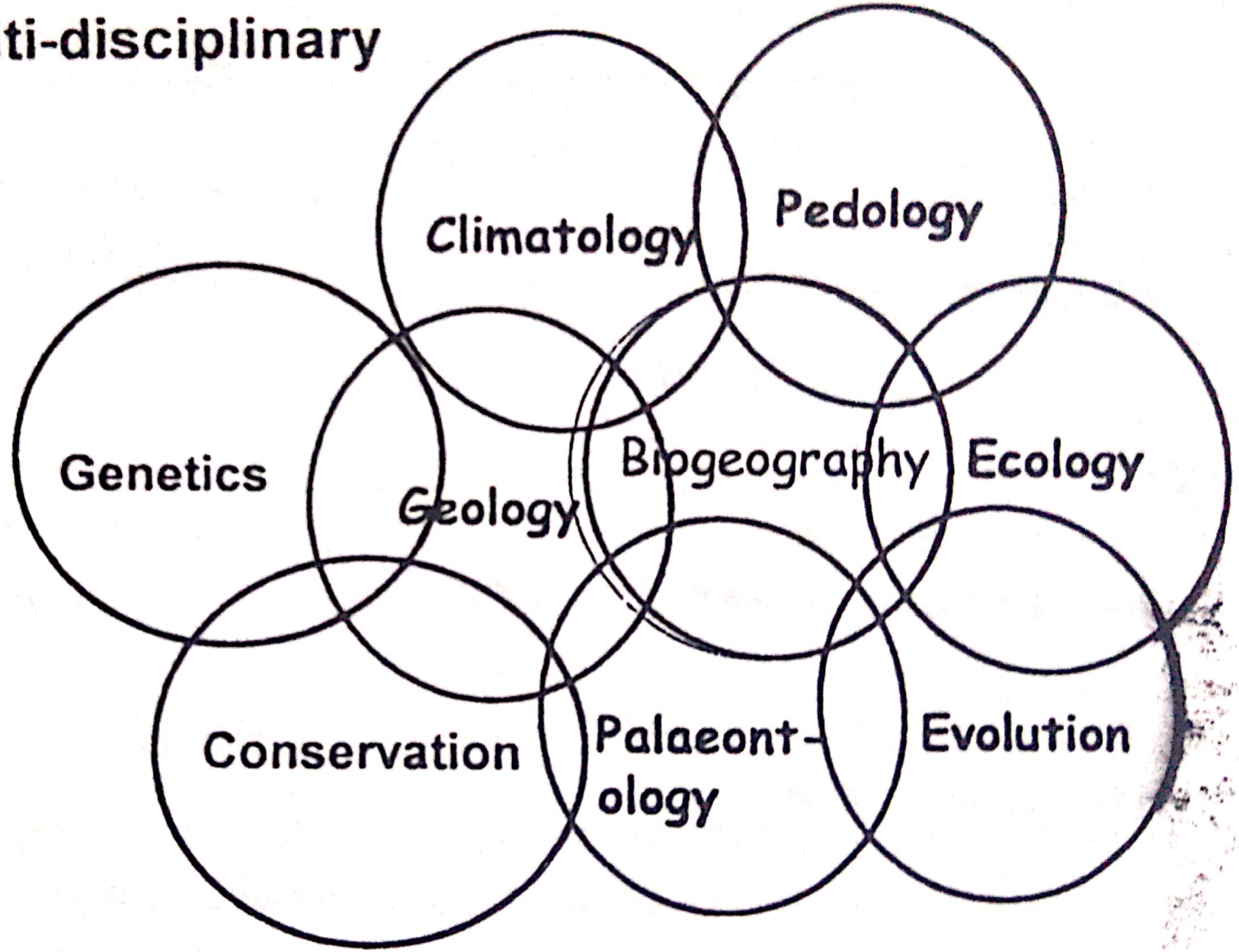
It is multi-disciplinary



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Biogeography cont'd.

- **Specialisations in biogeography**

  Zoogeography

  Phytogeography

  Microgeography

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Approaches to Biogeography

Historical biogeography

Ecological biogeography

Historical biogeography

- It is the study of how processes that occur over a long period of time cause changes in the distribution of species.

- It looks at how organisms that are presently located in a geographical region are related to organisms that lived in the same region in the past.

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- The current distribution of a species may be explained by the past distribution of same species or closely related species in the same region.

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Biogeography cont'd.

Continental drift and historical biogeography

- Some people believe that the Earth was made up of one single land mass called Pangaea.

- However, about 200 million years ago, the Pangaea (land mass) began to drift apart to form the different continents of today.

- People believe continental drift is a major factor that explains the current distribution of organisms in the world.

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Biogeography cont'd.

Biogeographic regions

- The continents of the world form biogeographic regions.

1) Nearctic: covers North America

2) Neotropical: covers South America

3) Oriental (Indo-Malayan): covers India, south and southeastern Asia

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Biogeography cont'd.

4) Palearctic: covers Europe, northern Asia, northern Africa

5) Australasia: covers Australia, New Zealand, Island of New Guinea

(6) Afrotropical (Ethiopian): covers

a) Africa (south of the Sahara Desert),

b) southern and eastern borders of the Arabian Peninsula,

c) island of Madagascar,

d) southern Iran and outermost southwestern Pakistan,

e) islands of the western Indian Ocean

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Biogeography cont'd.

Ecological biogeography

- This involves the study of the distribution of extant species in relation to the environment.

- The environmental factors include biotic factors such as other organisms, and abiotic factors such as climate, soil properties, etc.

- The Earth is divided into major ecological areas called biomes.

- Biomes are regions of distinct climate and plant life.

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Processes of biogeography

- There are 4 processes that are fundamental to biogeography; evolutionary change, dispersal, extinction, vicariance.

(1) Evolutionary change

- Evolutionary change is said to occur when *irreversible changes* occur in the genetic composition of a population.
- Evolution in species traits can influence the geographic range of the species.
- Example, dispersal and niche characteristics of a species can undergo evolution and change the geographic range of the species.

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Biogeography cont'd.

- The geographical range of a species is affected by two main factors; dispersal and environmental factors.

- If organisms are dispersed into areas where they cannot adapt, they will not survive.

- E.g. alligators are not found in Central North America because it becomes too cold in winter. Thus, the dispersal of this animal limits the geographical range of this species.

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(2) Dispersal

- Dispersal is the capacity of species to move from its area of birth to a new area.

- Without dispersal, genetic exchange between individuals is limited.

- In the absence of dispersal, individuals cannot move into new environments and therefore cannot adapt to new conditions in the environment.

- Dispersal is a key factor of evolution (Why????????).

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Barriers to dispersal

(a) Physiological barrier

- Physiological barrier occurs when conditions of the original environment of a species are so different from the conditions at the new environment, such that the species is unable to survive in them for very long.

- Example: amphibians and many freshwater fishes cannot survive for very long in salt water.

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(b) Ecological barrier

- The presence of other organisms in the new environment that threaten the survival of dispersed individuals. E.g. predation and competition.

- Animals often do not move to areas where they will face predation or competition. They rather disperse to areas with no predation or competition.

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(c) Physical barrier

- Any physical structure or distance that limits organisms' dispersal ability. E.g., mountain, ocean, huge distance, lakes etc.

- For instance, two suitable habitats hosting two different populations of a particular species may be separated by a huge distance or mountain such that individuals in each of the populations are not able to disperse to the other habitat.

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(3) Extinction

- Extinction is the process whereby a species or a group of taxa ceases to exist from their ecosystem.

- Extinction of a species from some areas can modify the geographic distribution of that species.

- Extinction usually results from human activities and climate change.

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(4) Vicariance

- Vicariance is said to occur when a barrier appears and causes the fragmentation of the distribution of an ancestral species, after which the descendant species may evolve in isolation

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Island Biogeography

- Island biogeography is the study of the distribution and dynamics of species in island environments.

- Due to their isolation from areas containing more widespread mainland species, islands are ideal places for unique species to evolve.

- Island species are very vulnerable to extinction. Why?

✓ It is due to limited geographical range.

✓ Low population size.

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Island Biogeography Cont'd.

- Species limited by small biogeographic range of islands often have low population numbers.

- The small population size of island species makes them prone to extinction due to natural disatsters such as fire, diseases, earthquake, etc.

- Anthropogenic factors such as habitat destruction, hunting, or biotic factors such as competition can also put intense pressure on island species.

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Island Biogeography Cont'd.

- Island populations therefore become vulnerable to population bottleneck, founder effect and genetic drift.

The theory of Island Biogeography

- The theory of island biogeography simply says that a larger island will have a higher number of species than a smaller island.

- In this theory, an island refers to any ecosystem that is remarkably different and isolated from the surrounding area.

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Island Biogeography Cont'd.

Factors affecting species diversity of islands

- Extinction
- Immigration
- Emigration
- Extent of isolation of the island, i.e. the proximity of the island to other ecosystems or mainland.
- Human disturbance
- Climate
- Natural disasters

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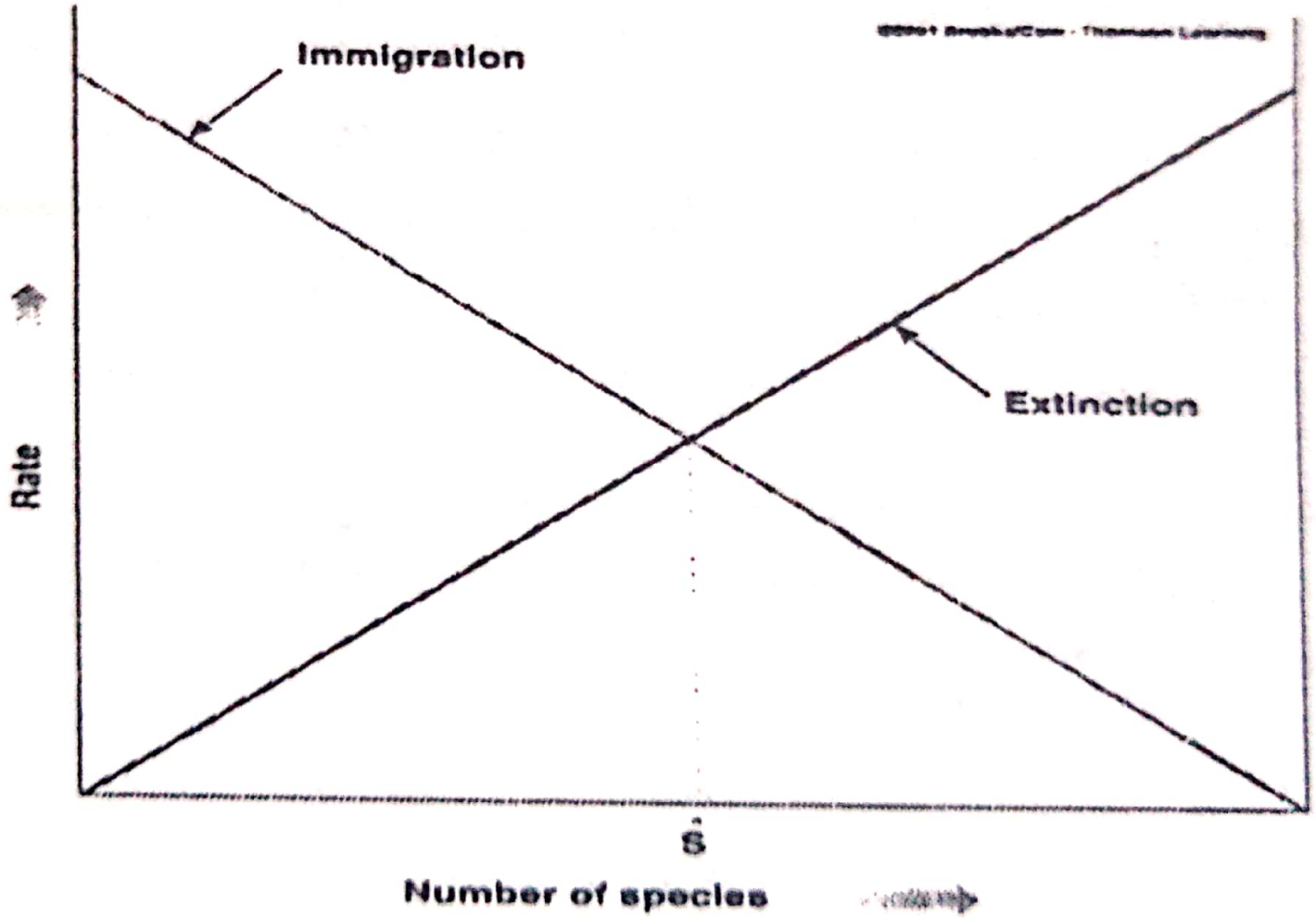
Island Biogeography Cont'd.

Equilibrium theory of island biogeography



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Island Biogeography Cont'd.

Equilibrium theory of island biogeography

- The theory states that the number of species present on an island is determined by a balance between immigration and extinction.

- An island is said to be in equilibrium when immigration rates = extinction rates

- What happens at this point?

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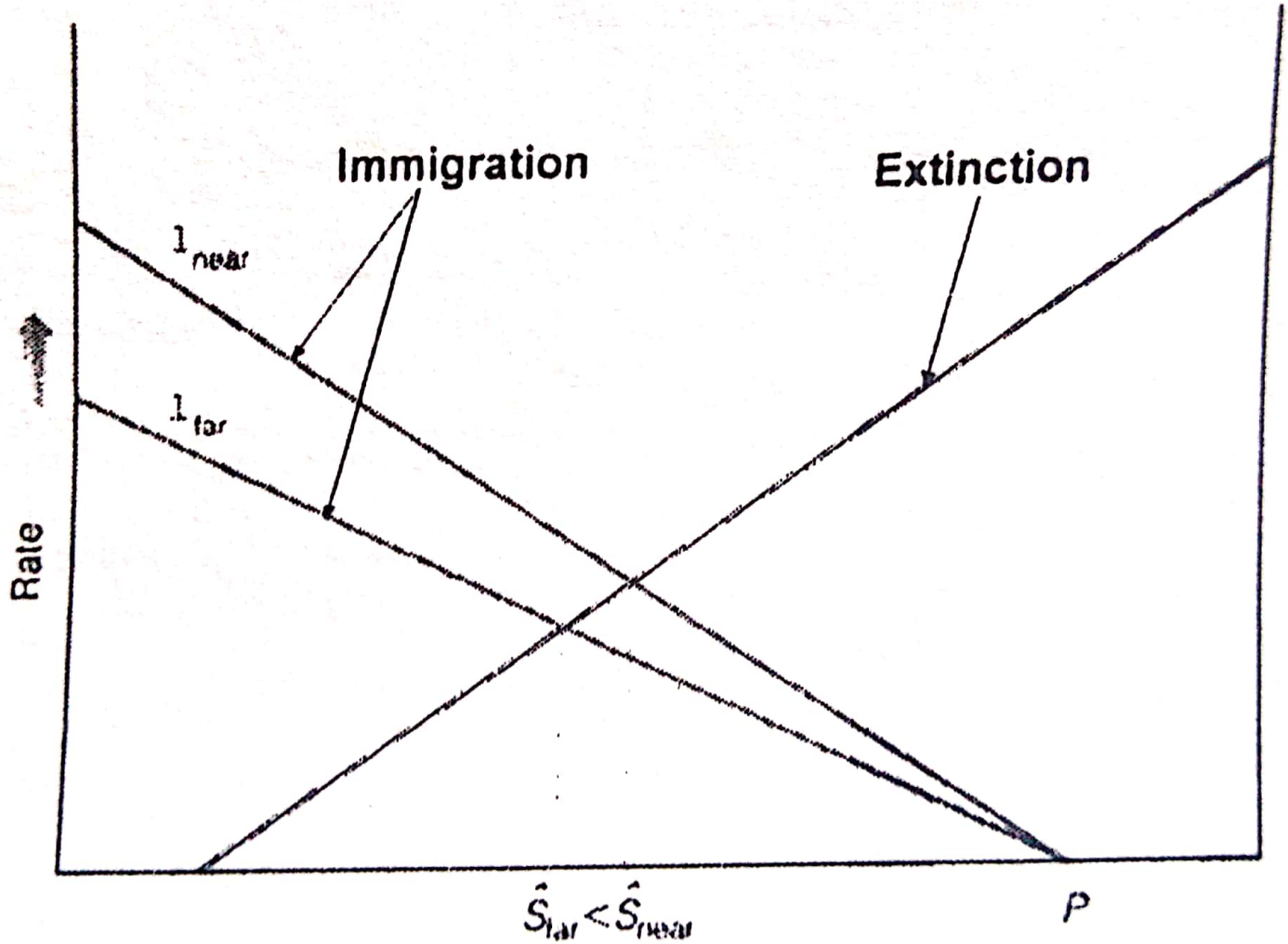
Class exercise

Use the island equilibrium theory to explain the effects of land size and distance on species richness of islands



a) Number of species

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Island Biogeography Cont'd.

Implications or applications of island biogeography

- Assignment

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Approaches to the study of species distribution

(1) Autecology (Species ecology)

- The study of the interactions of a single species or an individual organism with the biotic and abiotic factors in its habitat.

- It is usually an experimental approach, revealing the range of conditions (e.g., light, temperature, soil nutrients) which a particular species can tolerate, or which can support dispersal.

- The findings of autecological studies are used to interpret and/or predict patterns of diversity and distribution.

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(2) Synecology (Community ecology)

- The study of whole plant or animal communities with the biotic and abiotic factors in their habitat.

- Synecology takes into consideration species interactions in the communities before arriving at the distribution patterns of the organisms.

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