

Biogeography

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Concept:

Biogeography is the scientific study of the distribution of living organisms, exploring how and why species are distributed where they are. This field combines principles from biology, ecology, geography, geology, and evolutionary biology to uncover the intricate patterns and processes that shape life on Earth.

Exploring Diversity: It investigates the diversity of life across various scales, from global distributions of major biomes to the distribution of species within specific habitats. Biogeographers seek to understand the factors influencing these patterns, such as historical events, environmental conditions, dispersal mechanisms, and evolutionary processes.

Historical Context: One of its key aspects is exploring the historical factors that have shaped current distributions. This includes studying past geological events, climatic changes, continental drift, and how these factors have affected the evolution and dispersal of species over time.

Processes and Interactions: Biogeography examines the interactions between organisms and their environments. It looks at how factors like climate, geography, and habitat influence the survival, adaptation, and evolution of species. This involves understanding migration, speciation, extinction, and ecological interactions within and between different ecosystems.

Human Impact: In the modern era, biogeography also focuses on the impact of human activities on biodiversity and ecosystems. It studies how human-driven changes, like habitat destruction, climate change, introduction of invasive species, and pollution, affect the distribution and survival of species worldwide.

Applications: The insights gained from biogeography have practical applications in conservation, land management, and understanding the potential impacts of environmental changes. By recognizing patterns and processes that govern biodiversity, biogeographers contribute to efforts aimed at preserving and restoring ecosystems and species.

Overall, biogeography serves as a crucial tool for understanding the past, present, and future of life on Earth. Its interdisciplinary approach helps uncover the intricate relationships between organisms and their environments, shedding light on the complex tapestry of life's geographic story.

Concept of Biosphere

The biosphere encompasses the sum total of all ecosystems on Earth, where life thrives in a variety of forms and environments. It represents the interconnected web of life that spans across the planet, encompassing every living organism and their interactions with the atmosphere, hydrosphere (water bodies), and lithosphere (land).

Scope of the Biosphere: From the depths of the oceans to the highest mountains, from the polar ice caps to the most sweltering deserts, the biosphere encapsulates diverse habitats and ecosystems. It includes a staggering array of life forms, from microscopic bacteria to the largest mammals, from ancient trees to tiny algae.

Interconnectedness of Life: One of the defining characteristics of the biosphere is the intricate interconnectedness between living organisms and their environments. Organisms continuously interact with each other and with their surroundings, forming complex relationships that sustain life cycles and ecosystem functions.

Energy and Matter Flow: Within the biosphere, energy flows through ecosystems, sustaining life processes. Matter, in the form of nutrients and essential elements, cycles through organisms and the environment, ensuring the continuation of life-sustaining processes.

Adaptation and Evolution: Life within the biosphere has adapted to a wide range of environmental conditions, leading to an astonishing diversity of species. Evolutionary processes have shaped the characteristics of organisms, enabling them to survive and thrive in various habitats and conditions.

Human Impact: In recent times, human activities have significantly impacted the biosphere. Activities such as deforestation, pollution, habitat destruction, and climate change have altered ecosystems and threatened many species, leading to concerns about biodiversity loss and ecosystem degradation.

Importance and Conservation: The biosphere provides vital ecosystem services like clean air, water purification, climate regulation, and food production, making it essential for human survival and well-being. Conservation efforts aim to protect and sustainably manage the biosphere to ensure its continued ability to support life.

Understanding the biosphere is crucial for recognizing the interconnectedness of all life on Earth and for fostering responsible stewardship of our planet's resources. By studying and preserving the biosphere, we safeguard the intricate balance that supports the rich tapestry of life we are part of.

Classification of Biome

1. **Tundra:** Found near the poles, this biome experiences extremely cold temperatures and has a short growing season. Vegetation includes mosses, lichens, and hardy shrubs. Animals such as caribou, polar bears, and Arctic foxes are adapted to these harsh conditions.
2. **Taiga or Boreal Forest:** Dominated by coniferous trees like spruce, pine, and fir, the taiga biome is characterized by cold temperatures with short summers and long winters. Animals like moose, wolves, bears, and migratory birds thrive in these forests.
3. **Temperate Deciduous Forest:** These forests have distinct seasons with moderate temperatures. They are populated by trees that shed their leaves in fall, like oak, maple, and beech. Animals such as deer, squirrels, bears, and various bird species are common.
4. **Grassland or Prairie:** These vast expanses are characterized by grasses and few trees. They can be temperate or tropical. Animals like bison, gazelles, zebras, and prairie dogs are well adapted to these open habitats.

5. **Desert:** Arid and dry, deserts have little rainfall and extreme temperature variations. Vegetation is sparse and includes succulents and drought-resistant plants. Animals like camels, snakes, lizards, and certain rodents are adapted to survive in these harsh conditions.
6. **Tropical Rainforest:** Found near the equator, these biomes have high temperatures and rainfall throughout the year, leading to lush vegetation with a high diversity of plant and animal species. Trees, epiphytes, and a wide array of insects, birds, mammals, and reptiles inhabit these forests.
7. **Tropical Savanna:** Characterized by grasses and scattered trees, savannas have distinct wet and dry seasons. Animals like lions, elephants, giraffes, and zebras are well-known inhabitants of these biomes.
8. **Mediterranean:** Featuring mild, wet winters and hot, dry summers, Mediterranean biomes have vegetation adapted to periodic droughts. Olive trees, grapevines, and shrubs like lavender are common. Animals such as rabbits, foxes, and various bird species inhabit these areas.

Ecosystem:

An ecosystem refers to a community of living organisms interacting with each other and their physical environment within a particular area. These interactions involve the exchange of energy and matter, forming a complex web of relationships between organisms and their surroundings. Ecosystems can vary greatly in size, from small ponds to vast forests, and they can be terrestrial or aquatic.

Characteristics of Ecosystems:

1. **Biological Components:** Ecosystems comprise living organisms, including plants, animals, fungi, and microorganisms. These organisms interact and depend on each other for survival and reproduction.
2. **Abiotic Components:** Ecosystems also include non-living, or abiotic, factors such as soil, water, sunlight, temperature, and nutrients. These physical and chemical elements influence the structure and function of the ecosystem.
3. **Energy Flow:** Ecosystems operate on the flow of energy. Producers (like plants) harness energy from sunlight through photosynthesis and convert it into food. This energy is transferred through a food chain or food web as organisms consume each other.
4. **Nutrient Cycling:** Elements like carbon, nitrogen, phosphorus, and others cycle through the ecosystem. Decomposers break down dead organic matter, returning nutrients to the soil or water, allowing them to be reused by plants and other organisms.
5. **Self-regulation:** Ecosystems often have self-regulating mechanisms that help maintain a balance. For instance, predator-prey relationships can control population sizes, preventing overpopulation or extinction.

Types of Ecosystems:

1. **Terrestrial Ecosystems:** These include various land-based ecosystems such as forests, grasslands, deserts, and tundras. They are characterized by specific plant and animal adaptations to terrestrial conditions.

2. **Aquatic Ecosystems:** These encompass freshwater and marine environments, such as lakes, rivers, ponds, oceans, and coral reefs. Aquatic ecosystems have unique characteristics influenced by factors like salinity, water depth, and flow.
3. **Natural and Artificial Ecosystems:** Natural ecosystems develop and function without direct human intervention, while artificial or human-made ecosystems, like agricultural fields, gardens, or even aquariums, are intentionally created by humans and can exhibit different characteristics and dynamics.
4. **Microbial Ecosystems:** Microbial ecosystems exist at microscopic scales and play vital roles in nutrient cycling, decomposition, and other essential ecological processes. These can include environments like soil, the human gut, or hydrothermal vents.

Understanding different ecosystem types and their dynamics is crucial for conservation efforts, resource management, and maintaining the delicate balance of life on Earth. Each type of ecosystem has its own unique characteristics and plays a vital role in supporting biodiversity and sustaining life.

Concept of Community:

In ecology, a community refers to a group of populations of different species that live and interact within the same area and time. It's a complex assemblage of organisms coexisting and interacting with each other within a specific habitat or ecosystem.

1. **Interactions:** Communities consist of populations of different species interacting in various ways. These interactions can include competition for resources like food and shelter, predation, mutualism (beneficial interactions between species), parasitism, and more.
2. **Biotic Relationships:** The relationships within a community are primarily biotic, meaning they involve living organisms. These relationships contribute to the structure, diversity, and functioning of the community.
3. **Species Diversity:** The diversity of species within a community can vary widely. Some communities might have high species diversity, while others may be dominated by a few species.

Classification of Communities:

1. **Based on Habitat or Ecosystem Type:** Communities can be classified according to the type of habitat or ecosystem they inhabit, such as forest communities, aquatic communities (freshwater or marine), grassland communities, and desert communities.
2. **Successional Communities:** Communities can also be classified based on their stage in ecological succession. Primary successional communities develop in areas devoid of life, like bare rock or newly formed land. Secondary successional communities arise after disturbance in an already existing ecosystem, like after a fire or human intervention.

Components of a Community:

1. **Species:** The different species within a community form its fundamental components. These species interact with each other directly or indirectly, influencing each other's abundance and distribution.
2. **Population Dynamics:** Within each species, populations fluctuate in response to factors like competition, predation, reproduction rates, and environmental changes. These population dynamics play a crucial role in shaping the community structure.
3. **Trophic Relationships:** Communities are characterized by food webs or chains where species are linked through feeding relationships. Producers (plants) form the base, followed by herbivores, predators, and decomposers, creating a complex network of energy flow.
4. **Abiotic Factors:** While communities are primarily biotic, abiotic factors like temperature, water availability, soil composition, and sunlight also influence community structure and composition.

Ecotones

Ecotones represent dynamic and ecologically rich transition zones where two or more distinct habitats or ecosystems intersect. These areas are characterized by a blending or mixing of species, environmental conditions, and ecological processes from adjacent ecosystems, resulting in a unique mosaic of biodiversity.

Transitional Nature: Ecotones are not static; they continuously shift and evolve due to the interplay of factors from adjacent ecosystems. They can vary in width, from narrow boundaries to broader regions, depending on the ecosystems involved and the scale of observation.

High Biodiversity: The mixing of different environmental conditions, such as temperature, moisture, and soil types, in ecotones creates diverse niches that support a wide array of species. As a result, ecotones often host a greater diversity of plants, animals, and microorganisms than the adjacent ecosystems.

Unique Ecological Processes: Ecotones facilitate unique ecological interactions and processes. They can serve as corridors for species movement, allowing for gene flow and the spread of species between habitats. Additionally, they can act as zones of increased productivity due to the diverse resources available.

Challenges and Conservation: Ecotones are sensitive to environmental changes and human activities. Their delicate nature makes them vulnerable to disturbances, such as habitat fragmentation, invasive species encroachment, or land-use changes. Preserving ecotones is crucial for maintaining biodiversity and ecosystem resilience.

Examples and Significance: Examples of ecotones include areas where forests meet grasslands (forest-grassland ecotones), or where freshwater rivers merge with saltwater seas (estuaries). These zones play a crucial role in maintaining ecological balance and providing essential ecosystem services.

Concept of Ecology:

Ecology serves as a lens through which we comprehend the intricate connections that weave life on Earth. It unveils the symphony of interactions between organisms and their environment, painting a vivid picture of the diverse ecosystems that sustain life.

From the towering trees of forests to the microscopic life in soils, ecology explores the richness of biodiversity and the delicate balance of natural systems. It's a discipline that delves into the secrets of adaptation, survival, and the resilience of life forms in the face of environmental changes.

Understanding ecology isn't just about unraveling the complexity of nature; it's about realizing our interconnectedness with the natural world. It guides us in becoming responsible stewards of the environment, fostering sustainable practices that preserve the beauty and vitality of ecosystems for generations to come.

Through the lens of ecology, we witness the harmony of life, appreciate the marvels of adaptation, and recognize our role in nurturing and safeguarding the remarkable tapestry of life on our planet.

1. **Interconnectedness:** Ecology explores how organisms interact with each other and their environment. It looks at the flow of energy and nutrients, species relationships (competition, predation, symbiosis), and the influence of abiotic factors like climate, soil, and water.
2. **Levels of Organization:** Ecology spans various levels of biological organization, from individual organisms to populations, communities, ecosystems, and even the entire biosphere. It seeks to understand patterns and processes at each level and how they interact.
3. **Applied Ecology:** Beyond understanding natural systems, ecology has practical applications. It informs conservation efforts, ecosystem management, sustainable resource use, and the study of human impacts on the environment.

Components of Ecology:

1. **Biotic Components:** This includes living organisms within an ecosystem, such as plants, animals, fungi, bacteria, and other microorganisms. Their interactions and relationships shape the structure and functioning of ecosystems.
2. **Abiotic Components:** Non-living elements like sunlight, temperature, water, soil, air, nutrients, and geological factors are crucial in shaping ecosystems. These factors influence the distribution and behavior of organisms.
3. **Ecosystem Dynamics:** Ecology examines the flow of energy and nutrients within ecosystems, including processes like photosynthesis, respiration, decomposition, and nutrient cycling. These dynamics sustain life and influence ecosystem health.

Trophic

The trophic structure of an ecosystem refers to the organization of feeding relationships and energy transfer among different organisms within that ecosystem. It illustrates how energy

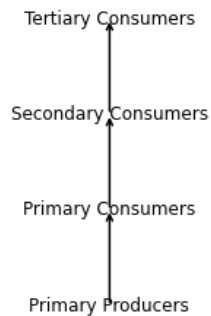
Structure:

flows through the ecosystem via feeding interactions among various levels of organisms, creating a hierarchical structure based on feeding relationships.

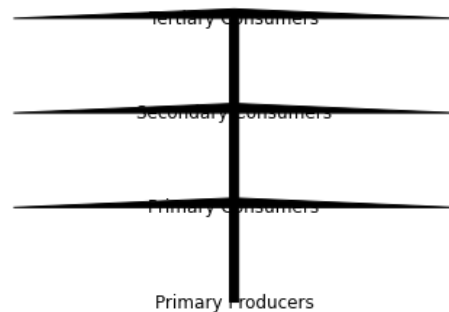
Components of Trophic Structure:

1. **Producers (Autotrophs):** At the base of the trophic structure are the primary producers—organisms capable of photosynthesis or chemosynthesis. They convert energy from sunlight or inorganic compounds into organic matter, generating food for the entire ecosystem. Examples include plants, algae, and certain bacteria.
2. **Primary Consumers (Herbivores):** These organisms feed directly on producers. They are the second trophic level and include animals that consume plants or algae for their energy needs. Examples include deer, rabbits, and grasshoppers.
3. **Secondary Consumers (Carnivores and Omnivores):** These organisms feed on the primary consumers. They occupy the third trophic level and include carnivores that eat herbivores and omnivores that consume both plants and animals. Examples include wolves, lions, and humans.
4. **Tertiary Consumers (Top Predators):** These organisms are at the top of the trophic structure and feed on secondary consumers. They often regulate population sizes of other species in the ecosystem. Examples include top predators like apex predators in a food chain, such as eagles, sharks, or large carnivorous mammals.
5. **Decomposers (Detritivores and Decomposer Organisms):** Decomposers play a crucial role in the trophic structure by breaking down organic matter from dead organisms or waste materials, returning nutrients to the soil or water. They include bacteria, fungi, and certain invertebrates like earthworms.

Trophic Structure



Trophic Structure Diagram



Key Points about Trophic Structure:

- Energy flows through the trophic levels, with a significant portion being lost at each level as heat during metabolic processes. This is known as the 10% rule, where only about 10% of energy is transferred from one trophic level to the next.
- Trophic structure influences the stability and functioning of ecosystems. Changes in one trophic level can have cascading effects throughout the entire system, impacting population sizes, species interactions, and ecosystem health.

- **Food Chain:**

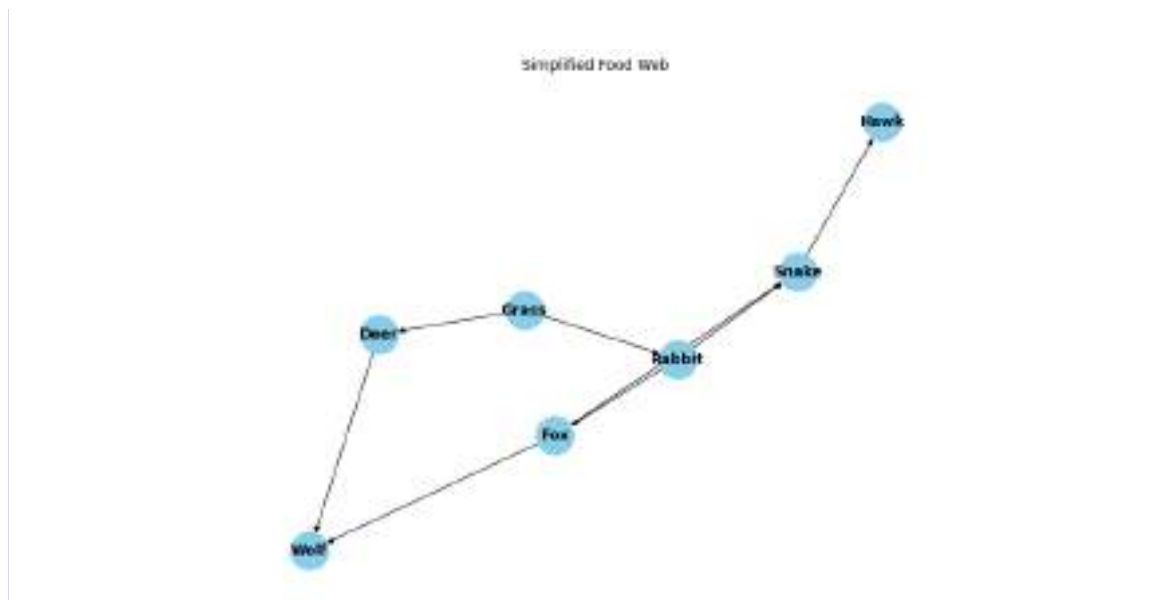
- A food chain represents a linear sequence of organisms, each consuming the one before it, showing the transfer of energy and nutrients from one trophic level to the next.
- For example:
- Grass → Grasshopper → Frog → Snake → Hawk
- Here, grass is the producer (autotroph) at the base of the chain, eaten by the grasshopper (primary consumer), which in turn is consumed by the frog (secondary consumer), and so on.

- **Food Web:**

- A food web is a more complex and interconnected model that represents multiple food chains overlapping within an ecosystem. It demonstrates the diverse feeding relationships among various organisms, including producers, consumers, and decomposers.
- For example:
- In a forest ecosystem, a food web might include multiple interlinked chains, where a single species might be part of various chains. It accounts for omnivores, species that have multiple food sources, and reflects the complexity of real-world ecosystems.
- Both food chains and food webs illustrate the transfer of energy and nutrients through trophic levels, but while a food chain represents a single linear pathway, a food web depicts the intricate and interconnected feeding relationships among various organisms within an ecosystem.

Simple Food Chain





Differentiate between food chain and food web:

Food Chain:

1. **Linear Structure:** A food chain is a simplified, linear representation of the flow of energy and nutrients in an ecosystem. It depicts a single, straightforward sequence of organisms, each feeding on the one before it and being consumed by the one after it.
2. **Limited Scope:** Food chains have a narrow focus, usually illustrating the transfer of energy through a few trophic levels, typically from producers (plants) to top consumers (predators).
3. **Unidirectional Flow:** Energy flows in a single direction along the chain, starting from producers (autotrophs) and moving through various levels of consumers (heterotrophs), with decomposers involved in breaking down dead organic matter.
4. **Less Complex:** They are simpler and easier to understand compared to food webs. They provide a clear representation of one pathway of energy transfer but may not capture the complexity of real ecosystems.

Food Web:

1. **Interconnected Structure:** A food web is a more complex and interconnected model that represents multiple food chains within an ecosystem. It includes numerous interconnected and overlapping chains that depict the various feeding relationships among organisms.
2. **Comprehensive Representation:** Food webs provide a more comprehensive view of the feeding interactions in an ecosystem, including multiple species and their interactions with each other, illustrating the complexity of trophic relationships.
3. **Omnidirectional Flow:** Energy and nutrients flow in multiple directions within a food web, as organisms often have multiple food sources and can occupy different trophic levels. This reflects the reality that most organisms have multiple interactions within an ecosystem.
4. **Reflects Real Ecosystems:** Food webs more accurately represent the complexity and dynamics of ecosystems, accounting for the intricate relationships between various species, including omnivores, predators, prey, and decomposers.

Concept of Biodiversity:

1. **Genetic Diversity:** This aspect refers to the variety of genes within a species. It's crucial for the adaptation and resilience of populations to environmental changes and influences the ability of species to survive and evolve.
2. **Species Diversity:** Species diversity is the variety and abundance of different species within a specific area. It includes both the number of species present (species richness) and their relative abundance (species evenness).
3. **Ecosystem Diversity:** Ecosystem diversity relates to the variety of ecosystems within a larger area. It includes different habitats, communities, and ecological processes, ranging from forests and grasslands to wetlands and marine environments.

Nature of Biodiversity:

1. **Complexity:** Biodiversity is immensely complex, spanning a wide range of organisms, from microscopic bacteria to large mammals, and includes interactions among these organisms within ecosystems.
2. **Interconnectedness:** Species and ecosystems are interconnected and interdependent. Changes in one part of an ecosystem can have cascading effects on other organisms and the overall ecosystem functioning.
3. **Dynamic and Evolving:** Biodiversity is not static. It evolves over time due to natural processes like speciation and extinction. However, human activities, such as habitat destruction and climate change, are accelerating these changes.

Types of Biodiversity:

1. **Alpha Diversity:** It refers to biodiversity within a specific habitat or ecosystem.
2. **Beta Diversity:** Beta diversity measures the change in species composition between different habitats or ecosystems within a larger area.
3. **Gamma Diversity:** Gamma diversity represents biodiversity at the regional or landscape level, encompassing all habitats and ecosystems within a broader geographical area.
4. **Functional Diversity:** This aspect focuses on the variety of functional traits and roles that species perform within an ecosystem, such as their contributions to nutrient cycling or ecosystem stability.