6th Semester Unit 3
Syllabus:

Definition of systematics; taxonomic identification; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept of species (taxonomic, typological, biological, evolutionary, phylogenetic); *Biogeographical rules - Gloger's rule, Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species. Application of biogeographical rules in design of protected area and biosphere reserves.*

1. Biogeographical Rules

a) State Gloger's rule and Bergmann's rule with examples. (2)

b) Explain how Allen's rule and Geist's rule influence animal adaptations. (3)

c) Discuss the significance of biogeographical rules in wildlife conservation and habitat management. (5)

1. Biogeographical Rules

a) State Gloger's rule and Bergmann's rule with examples. (2 marks)

Gloger's Rule: This rule states that within a species, individuals in warmer and more humid climates tend to have darker pigmentation (melanism) than those in cooler, drier regions. This is due to increased melanin, which provides better resistance to UV radiation and microbial infections.

Example: Birds like the House Sparrow (Passer domesticus) exhibit darker plumage in tropical regions compared to temperate zones (Delhey, 2019).

Bergmann's Rule: This rule states that within a broadly distributed species, individuals in colder climates tend to be larger in body size than those in warmer regions, as larger bodies have a lower surface-area-to-volume ratio, reducing heat loss.

Example: The Brown Bear (Ursusarctos) shows larger body sizes in Arctic populations compared to those in temperate forests (Meiri& Dayan, 2003).

b) Explain how Allen's rule and Geist' rule influence animal adaptations. (3 marks)

Allen's Rule: This rule states that endothermic animals in colder climates have shorter limbs and appendages to minimize heat loss, while those in warmer climates have elongated limbs to facilitate heat dissipation.

Example: Arctic foxes (Vulpeslagopus) have shorter ears and limbs compared to desert-dwelling fennec foxes (Vulpeszerda), which have large ears for thermoregulation (Hesse et al., 1951).

Geist's Rule: Proposed by Valerius Geist, this rule suggests that in seasonal environments, animals evolve larger body sizes and more efficient energy storage mechanisms to survive harsh winters.
Example: Moose (Alcesalces) in northern latitudes have larger body sizes and thicker fur compared to their southern counterparts (Geist, 1987).

c) Discuss the significance of biogeographical rules in wildlife conservation and habitat management. (5 marks)

Biogeographical rules provide critical insights into species adaptations, helping conservationists design effective management strategies:
Protected Area Design: Bergmann's and Allen's rules help predict how species might respond to climate change, aiding in the selection of reserves that support genetic diversity (Gaston et al., 2008).
Assisted Migration: Understanding size and morphological variations (per Gloger's and Allen's rules) ensures that relocated species can adapt to new environments (Hoegh-Guldberg et al., 2008).
Habitat Corridors: Geist's rule emphasizes the need for large, connected habitats for species requiring seasonal migrations (e.g., elk and bison).
Climate Resilience Planning: These rules help model future species distributions under warming scenarios, guiding conservation priorities (Chen et al., 2011).

References:
Delhey, K. (2019). Biological Reviews, 94(2).
Meiri, S., & Dayan, T. (2003). Journal of Biogeography, 30(3).
Geist, V. (1987). Evolutionary Ecology, 1(4).
Chen, I. C., et al. (2011). Science, 333(6045).

2. Biogeographical Realms and Their Fauna
a) Name any two biogeographical realms and their characteristic fauna. (2)
b) Compare the faunal diversity of the Neotropical and Palearctic realms. (3)
c) Explain how the concept of biogeographical realms helps in biodiversity conservation planning. (5)

2. Biogeographical Realms and Their Fauna

a) Name any two biogeographical realms and their characteristic fauna. (2 marks)
Neotropical Realm: Includes Amazon rainforests; fauna includes jaguars (Pantheraonca), macaws (Ara spp.), and capybaras (Hydrochoerushydrochaeris).
Palearctic Realm: Covers Eurasia; fauna includes brown bears (Ursusarctos), wolves (Canis lupus), and Siberian tigers (Pantheratigrisaltaica).

b) Compare the faunal diversity of the Neotropical and Palearctic realms. (3 marks)

Feature	Neotropical Realm	Palearctic Realm
Biodiversity	Highest diversity (e.g., 30% of global bird species)	Lower diversity but high endemism in cold-adapted species
Endemism	High (e.g., sloths, anteaters)	Moderate (e.g., snow leopards, saiga antelope)
Adaptations	Tropical adaptations (bright colors, arboreal life)	Cold adaptations (thick fur, hibernation)

The Neotropical realm is more species-rich due to stable tropical climates, whereas the Palearctic has fewer but highly specialized species (Wallace, 1876).

c) Explain how the concept of biogeographical realms helps in biodiversity conservation planning. (5 marks)

1. **Prioritizing Conservation Hotspots:** Realms like the Neotropics and Indo-Malaya are biodiversity hotspots requiring urgent protection (Myers et al., 2000).
2. **Endemic Species Protection:** Realms with high endemism (e.g., Australasia's marsupials) need targeted conservation.
3. **Climate Change Mitigation:** Realms help predict species shifts; Arctic species may need corridors for migration (Hannah et al., 2007).
4. **Policy Frameworks:** UNESCO Biosphere Reserves are often designed based on realm-specific biodiversity (UNESCO, 1996).

References:

Myers, N., et al. (2000). *Nature, 403*.
Hannah, L., et al. (2007). *PNAS, 104*(20).

3. Endemic, Rare, Exotic, and Cosmopolitan Species

a) Define endemic and exotic species with one example each. (2)

b) Differentiate between rare and cosmopolitan species. How do they impact ecosystems? (3)

c) Discuss the challenges in conserving endemic species and controlling exotic species in protected areas. (5)

3. Endemic, Rare, Exotic, and Cosmopolitan Species

1) **Define endemic and exotic species with one example each. (2 marks)**

a) **Endemic Species:** Species that are naturally restricted to a specific geographic region and are not found anywhere else in the world.
Example: The Lemurs of Madagascar (*Lemuroidea*) are endemic to Madagascar due to the island's long isolation (Goodman &Benstead, 2005).

b) **Exotic (Alien) Species:** Species introduced outside their natural range, either intentionally or accidentally, often disrupting local ecosystems.
Example: The Nile Perch (*Latesniloticus*), introduced into Lake Victoria, caused the extinction of hundreds of native cichlid fish (Lowe et al., 2000).

b) Differentiate between rare and cosmopolitan species. How do they impact ecosystems? (3 marks)

Feature	Rare Species	Cosmopolitan Species
Distribution	Limited to small, specific areas	Found across multiple continents
Abundance	Low population numbers	Often abundant where present
Ecological Role	Highly specialized, vulnerable to extinction	Generalists, often invasive

Ecological Impact:

1. **Rare species** (e.g., **Javan Rhino, *Rhinoceros sondaicus***) indicate ecosystem health; their loss disrupts niche functions (Primack, 2014).
2. **Cosmopolitan species** (e.g., **House Sparrow, *Passer domesticus***) can outcompete natives, reducing biodiversity (Sax & Gaines, 2003).

c) Discuss the challenges in conserving endemic species and controlling exotic species in protected areas. (5 marks)

Challenges in Conserving Endemic Species:

1. **Habitat Fragmentation:** Endemics often have small ranges (e.g., **Hawaiian Honeycreepers**), making them vulnerable to deforestation (Pimm et al., 2014).
2. **Climate Change:** Shifts in temperature may render their habitats unsuitable (Thomas et al., 2004).
3. **Limited Genetic Diversity:** Small populations face inbreeding risks (Frankham, 2005).
4. **Challenges in Controlling Exotic Species:**
5. **Rapid Spread:** Species like **Water Hyacinth (*Eichhorniacrassipes*)** multiply quickly, clogging waterways (Vilà et al., 2010).
6. **Lack of Natural Predators:** Exotics (e.g., **Brown Tree Snake, *Boigairregularis*** in Guam) dominate due to no natural checks (Rodda&Savidge, 2007).
7. **Economic Costs:** Eradication programs are expensive (e.g., **Zebra Mussel control in the Great Lakes** costs ~$500M/year (Lovell et al., 2006)).

Management Strategies:

1. **Endemics:** Habitat corridors, captive breeding (e.g., **Kakapo Recovery Program**).
2. **Exotics:** Early detection, biological control (e.g., **Cane Toad predators in Australia**).

References:

Goodman, S. M., &Benstead, J. P. (2005). *The Natural History of Madagascar*.
Sax, D. F., & Gaines, S. D. (2003). *Trends in Ecology & Evolution, 18*(9).
Pimm, S. L., et al. (2014). *Science, 344*(6187).

4. Application of Biogeographical Rules in Protected Areas
a) How does Bergmann's rule influence the design of a wildlife sanctuary? (2)
b) Explain how Allen's rule is considered while planning a biosphere reserve. (3)
c) Evaluate the role of biogeographical principles in the selection and management of protected areas. (5)

4. Application of Biogeographical Rules in Protected Areas.

a) How does Bergmann's rule influence the design of a wildlife sanctuary? (2 marks)
Bergmann's rule suggests that species in colder areas are larger, requiring sanctuaries in high latitudes/altitudes to provide:

i) Larger Territories (e.g., Siberian Tiger reserves need expansive ranges).
ii) Climate-Adapted Vegetation (e.g., Boreal forests for Brown Bears) (Meiri& Dayan, 2003).

b) Explain how Allen's rule is considered while planning a biosphere reserve. (3 marks)

Allen's rule dictates that animals in colder climates have shorter appendages. Reserves must account for:

1. **Microhabitats:** Sheltered areas for species with reduced extremities (e.g., **Arctic Fox dens**).
2. **Thermal Zones:** Gradients from warm core areas to cooler peripheries (Hesse et al., 1951).
3. **Corridor Design:** Ensuring short-limbed species (e.g., **Snowshoe Hare**) can move without heat stress (Beever et al., 2017).

c) Evaluate the role of biogeographical principles in the selection and management of protected areas. (5 marks)

1. **Selection Criteria:**
    a. **Species-Environment Matching:** Bergmann's/Allen's rules help predict suitable habitats (e.g., **Alpine reserves for Mountain Goats**).
    b. **Hotspot Identification:** Endemic-rich realms (e.g., **Western Ghats, India**) prioritized (Myers et al., 2000).

Management Strategies:
1. **Climate Resilience:** Using Geist's rule to plan for seasonal resource needs (e.g., **Migratory routes for Caribou**).
2. **Invasive Species Control:** Cosmopolitan species monitored per island biogeography theory (MacArthur & Wilson, 1967).
3. **Zoning:** Core areas for endemics, buffers for generalists (UNESCO, 1996).

4. **Case Study: Yellowstone National Park** uses Bergmann's rule to manage **Bison herds**, ensuring large winter ranges.

References:

MacArthur, R. H., & Wilson, E. O. (1967). *The Theory of Island Biogeography*.
Beever, E. A., et al. (2017). *Bioscience, 67*(8).