



Biodiversity



- Different kinds of living organisms present on earth together constitutes Biodiversity.
- The term Biodiversity was popularized by Edward Wilson



IUCN



International union for Conservation of Nature and Natural Resources



Red Data Book

NCERT → 2004 Data → The total discovered species so far are slightly more than 1.5 million.

Living World → Taxonomically Known species 1.7-1.8 million.

Some Scientists believe that Species on earth are about 20 to 50 million.

Robert May

Species on earth → 7 million.



Assertion: Species inventories are more complete in temperate area than in Tropic areas.

Reason: Species diversity is much more in tropical areas as compared to Temperate areas

Types of Diversity

Genetic Diversity

within the same/
single species

Species Diversity

At species level
(i.e. between
different species)

Ecological Diversity

At large scale
‘At ecosystem level’

(i) **Genetic diversity:** A single species might show high diversity at the genetic level over its distributional range. The genetic variation shown by the medicinal plant *Rauwolfia vomitoria* growing in different Himalayan ranges might be in terms of the potency and concentration of the active chemical (reserpine) that the plant produces. India has more than 50,000 genetically different strains of rice, and 1,000 varieties of mango.

R. Vomitoria
chemical → 'Reserpine'

More than
50,000 Varieties
of Rice

Mango
1,000 varieties

- (ii) **Species diversity:** The diversity at the species level, for example, the Western Ghats have a greater amphibian species diversity than the Eastern Ghats.
- (iii) **Ecological diversity:** At the ecosystem level, India, for instance, with its deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows has a greater ecosystem diversity than a Scandinavian country like Norway.

Species diversity

Western Ghats > Eastern Ghats
Amphibian species

India > Norway
Diversity Diversity

Let us look at some interesting aspects about earth's biodiversity based on the currently available species inventories. More than 70 per cent of all the species recorded are animals, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than 22 per cent of the total. Among animals, insects are the most species-rich taxonomic group, making up more than 70 per cent of the total. That means, out of every 10 animals on this planet, 7 are insects. Again, how do we explain this enormous diversification of insects? The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals. In Figure 13.1, biodiversity is depicted showing species number of major taxa.

Fungi > Fishes + Amphibians + Reptiles + Mammals



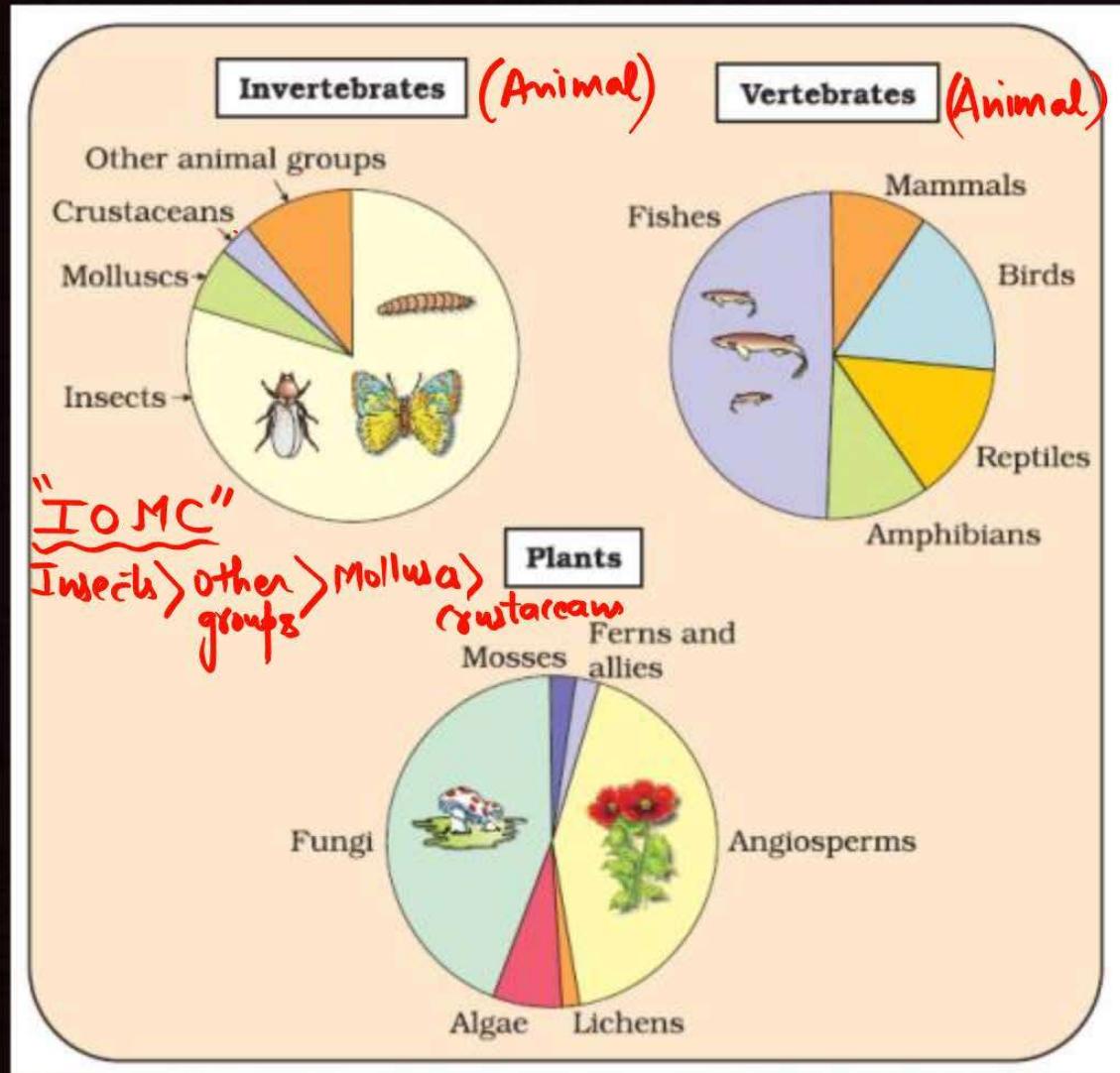
Reason for Diversification of Insects

1. Strong chitinous or cuticular exoskeleton

↓

Get protection (High survival rate)

2. Small size
3. High reproductive rate
4. Found everywhere



Vertebrates

FB Pe RAM

Fishes > Birds > Reptiles >
Amphibians > Mammals

AFAMFL

Angiosperms > Fungi > Algae
> Mosses > Ferns > Lichens

Why Bacteria is not placed in pie-chart?

It should be noted that these estimates do not give any figures for prokaryotes. Biologists are not sure about how many prokaryotic species there might be. The problem is that conventional taxonomic methods are not suitable for identifying microbial species and many species are simply not culturable under laboratory conditions. If we accept biochemical or molecular criteria for delineating species for this group, then their diversity alone might run into millions.



India

→ Tropical country

In whole World

We have **2.4%** of total world's
(Land area)

The **Biodiversity**
India Contribution is **8.1%**

12 Megadiverse countries

1st Place → Brazil – Tropical country
(South America) (Amazon Forest)

8th Place → India (Tropical Country)



India

45,000 species → Plants

More than 90,000 → Animals

According to Robert May

Only 22% species are discovered

If this is applied to India

More than 1,00,000 → plants

More than 3,00,000 → Animals species



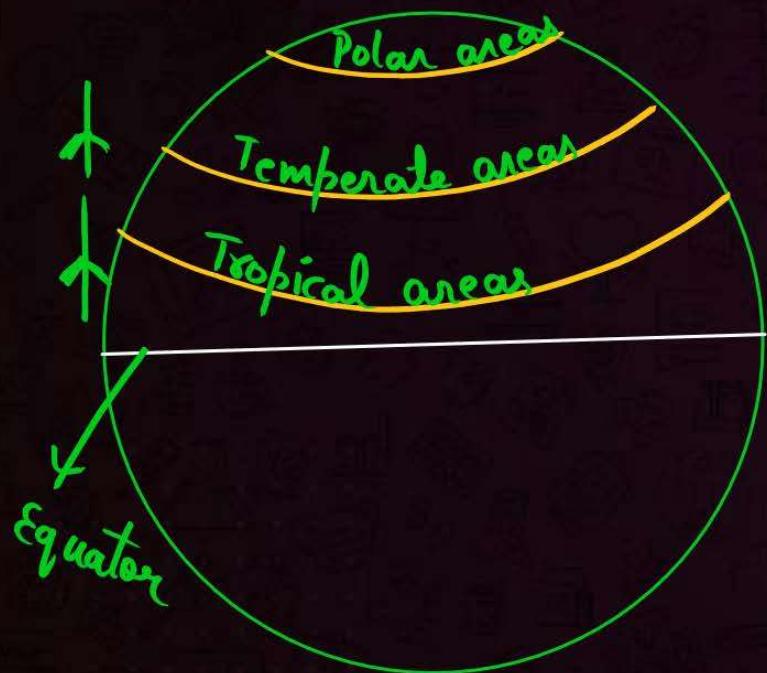
Patterns of Biodiversity



① Latitudinal Range

② Species-area Relationship

1. Latitudinal Range/latitudinal gradient



As we move
(towards pole)
away from equator.

- Latitude increases
- Altitude / Height increases
- Species diversity decreases

As we move
towards Equator
(Away pole)

- Latitude decreases
- Altitude/Height decreases
- Species diversity increases

Examples:

1. **Colombia** (Tropical country)

Latitudinal Range → **23.5°N to 23.5° S**

Birds Diversity → **1400 species**

2. **New York** (Temperate)

Latitudinal Range → **41° N**

Birds Diversity → **105**

3. **Greenland** (Polar Country)

Latitudinal Range → **71° N**

Birds Diversity → **56**

India



(Tropical Country)

Birds
species → 1200

Equador

(Tropical Country)

(7th Place)

↓
"Megadiverse"

10 times more Vascular

plants

(Pteridophytes,
Gymno, Angiosperms)
than Midwest of USA
(Temperate Area)

Amazon Forest Brazil (South America)
(Most Diverse)

↳ "Tropical country"

1. Plants → More than 40,000 species
2. Fishes → 3,000 species
3. Birds → 1300 species
4. Mammals → 427
5. Amphibians → 427
6. Invertebrate animals → More than 1,25,000
7. Reptiles → 378

QUESTION



The variation shown by the medicinal plant *Rauwolfia vomitoria* growing in different Himalayan ranges represents

- A Genetic diversity
- B Species diversity
- C Ecological diversity
- D Community diversity

QUESTION

India has 2.4 % of the world's land area, its share of the global species diversity is an impressive 8.1 %.

A 8.1, 2.4

B 22, 12

C 12, 22

D 2.4, 8.1

Ques : Why Tropics have more Biodiversity than Temperature area?

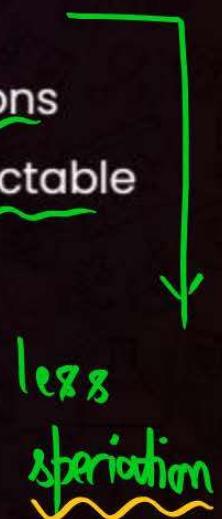
Tropical Areas

1. Available solar energy → more
2. Disturbances → Less
 - (i) Seasonal (ii) Glaciations
3. Constant and Predictable
4. High Productivity



Temperate Areas

1. Available solar energy → Less
2. Disturbances → More
 - (i) Seasonal (ii) Glaciations
3. Changing and not predictable
4. Less productivity



What is so special about tropics that might account for their greater biological diversity? Ecologists and evolutionary biologists have proposed various hypotheses; some important ones are (a) Speciation is generally a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification, (b) Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments promote niche specialisation and lead to a greater species diversity and (c) There is more solar energy available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

QUESTION

Select incorrect statement w.r.t. greater biological diversity in tropics

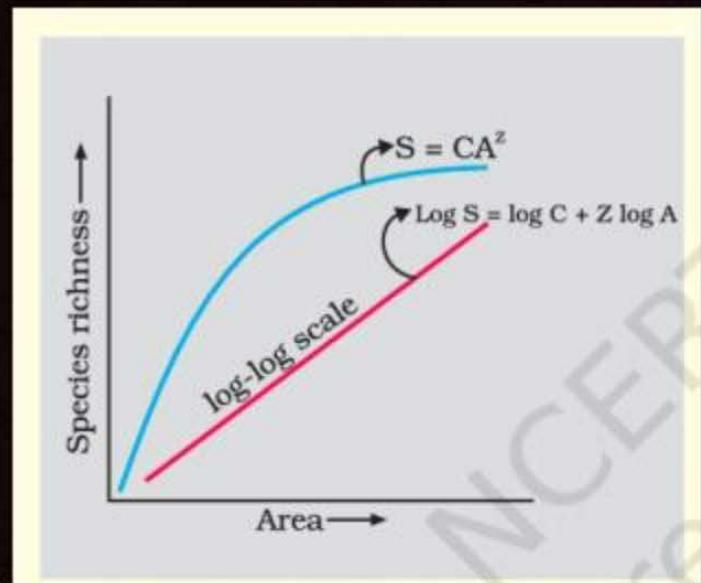
- (A) Tropical latitudes have remained relatively undisturbed for millions of years and thus had a long evolutionary time for species diversification. ✓
- (B) Tropical environments are more seasonal and less predictable than temperates. ✗
- (C) There is more solar energy available which contributes to higher productivity.

- A** A and B
- B** Only B
- C** B and C
- D** Only A

Species -area relationship

→ German Naturalist / Geographer

Alexander Von Humboldt



$$S = \text{Species richness}$$

$$A = \text{Area}$$

$$* (Z)$$

As area increases species diversity increases
but upto a limit.

Area of Species richness

$S = CA^z \rightarrow$ Rectangular Hyperbola

$\log S = \log C + Z \log A \rightarrow$ straight line

Ecologists have discovered that the value of Z lies in the range of 0.1 to 0.2, regardless of the taxonomic group or the region (whether it is the plants in Britain, birds in California or molluscs in New York state, the slopes of the regression line are amazingly similar). But, if you analyse the species-area relationships among very large areas like the entire continents, you will find that the slope of the line to be much steeper (Z values in the range of 0.6 to 1.2). For example, for frugivorous (fruit-eating) birds and mammals in the tropical forests of different continents, the slope is found to be 1.15. What do steeper slopes mean in this context?

Z = Regression coefficient

↳ Slope

Z value → More

Slope → steep

Area → More

Z-value → less

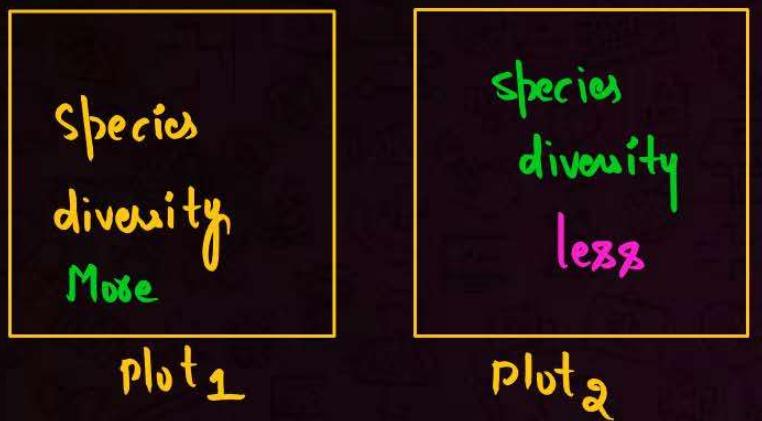
Slope → less steep

Area → smaller

Country → Z value → $0.1 - 0.2$

Continent → $Z \rightarrow 0.6 - 1.2$

David Tilman's experiment



Conclusion:

Plot 1 → Stability more
Plot 2 → Stability less

Species diversity & Stability of Ecosystem

Properties of "Stable Ecosystem".

- (a) High Productivity
- (b) Resistant to Man-made or Natural disturbances.
- (c) Resilient → Can revive itself
- (d) Resistant to Alien-species invasion
- (e) less variation in productivity from year to year



RIVET POPPER HYPOTHESIS

→ By PAUL EHRLICH

↓ Nut-bolt ↳ Remove

Ecosystem → Aeroplane

Rivets → Species

Rivets on wings → Keystone species

* Removing species destabilizes Ecosystem

* Removing Key-stone

Species crashes the Ecosystem.

Key-stone species

↓ Must important species

Balances the Ecosystem.

→ Tiger

→ lion

→ wolf

→ "Fig" (Ficus)

13.1.4 Loss of Biodiversity

While it is doubtful if any new species are being added (through speciation) into the earth's treasury of species, there is no doubt about their continuing losses. The biological wealth of our planet has been declining rapidly and the accusing finger is clearly pointing to human activities. The colonisation of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds. The IUCN Red List (2004) documents the extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years. Some examples of recent extinctions include the dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of tiger. The last twenty years alone have witnessed the disappearance of 27 species. Careful analysis of records

Yaad
last 20 years
+
27 species



Dodo
(Mauritius)



"Quagga" (Africa)



Stellar's Sea Cow (Russia)

Bali



Caspian



Thylacine
(Australia)



Javan (Asia)

shows that extinctions across taxa are not random; some groups like amphibians appear to be more vulnerable to extinction. Adding to the grim scenario of extinctions is the fact that more than 15,500 species, world-wide are facing the threat of extinction. Presently, 12 per cent of all bird species, 23 per cent of all mammal species, 32 per cent of all amphibian species and 31 per cent of all gymnosperm species in the world face the threat of extinction.

"Amphibians" (*Animals*)

Vulnerable to extinction

12%	→ Bird species
23%	→ Mammals
32%	→ Amphibians
31%	→ Gymnosperms (<i>Plants</i>)

under threat to Extinction

Mass - Extinction

↗(S)

Mass
Extinction



From a study of the history of life on earth through fossil records, we learn that large-scale loss of species like the one we are currently witnessing have also happened earlier, even before humans appeared on the scene. During the long period (> 3 billion years) since the origin and diversification of life on earth there were five episodes of mass extinction of species. How is the 'Sixth Extinction' presently in progress different from the previous episodes? The difference is in the rates; the current species extinction rates are estimated to be 100 to 1,000 times faster than in the pre-human times and our activities are responsible for the faster rates. Ecologists warn that if the present trends continue, nearly half of all the species on earth might be wiped out within the next 100 years.

Sixth Extinction → 100-1,000 times faster

In general, loss of biodiversity in a region may lead to (a) decline in plant production, (b) lowered resistance to environmental perturbations such as drought and (c) increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycles.



Evil Quartet



4 Reasons of Loss Biodiversity

- **Habitat Fragmentation and loss**
(Major Reason of Biodiversity Loss)
- **Alien species Invasion**
- Coextinction
- Over exploitation

Habitat loss and fragmentation: This is the most important cause driving animals and plants to extinction. The most dramatic examples of habitat loss come from tropical rain forests. Once covering more than 14 per cent of the earth's land surface, these rain forests now cover (no more than 6 per cent). They are being destroyed fast. By the time you finish reading this chapter, 1000 more hectares of rain forest would have been lost. The Amazon rain forest (it is so huge that it is called the 'lungs of the planet') harbouring probably millions of species is being cut and cleared for cultivating *soya beans* or for conversion to grasslands for raising beef cattle. Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species. When large habitats are broken up into small fragments due to various human activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to population declines.

Amazon
Forest
(Tropical Rain
Forest)



Amazon Forest

- a) Soyabean Cultivation ✓
- b) Grasslands are formed for Cattles. ↗

Over-exploitation: Humans have always depended on nature for food and shelter, but when 'need' turns to 'greed', it leads to over-exploitation of natural resources. Many species extinctions in the last 500 years (Steller's sea cow, passenger pigeon) were due to overexploitation by humans. Presently many marine fish populations around the world are over harvested, endangering the continued existence of some commercially important species.

Passenger Pigeon ✓

✓ Stellar's Sea Cow



✗ Exotic species

Alien species invasions: When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species. The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake. You must be familiar with the environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (*Parthenium*), *Lantana* and water hyacinth (*Eichornia*). The recent illegal introduction of the African catfish *Clarias gariepinus* for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.



Like Victoria (East Africa)

Indigenous species → Cichlid fish

1. Nile perch



(Alien Species)
(Exotic)

Due to Nile Perch
200 cichlid
species were
extinction

→ Came in India with "Imported wheat"

2. Parthenium (Carrot grass)
(Problematic weed)



Parthenium

3. Lantana
(Problematic weed)



Lantana

4. Water hyacinth
(Eichhornia) (Terror of Bengal)



Eichhornia

5. Clarias "African catfish"
Responsible for Extinction
"indigenous catfishes"



Clarius

Co-extinctions: When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct. When a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate. Another example is the case of a coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

obligate Mutualism

- ① Fig & wasp
- ② Psorophora moth & Yucca plant

QUESTION

Species area relationships among very large areas like the entire continents the Z values in the range of

- A 0.1 to 0.2 (country)
- B 1.15
- C 0.3 to 0.6
- D 0.6 to 1.2

QUESTION

Extinction of more than 200 species of cichlid fish in Lake Victoria was due to introduction of

African catfish

Nile perch

Clarias gariepinus

Lantana

QUESTION



Assertion: Biodiversity of the prokaryotes cannot be estimated.

Reason: Conventional taxonomic methods are not suitable for identification and characterisation of microbes.



- A Both Assertion and Reason are true and the Reason is a correct explanation of the Assertion
- B Both Assertion and Reason are true but Reason is not a correct explanation of the Assertion
- C Assertion is true but Reason is false.
- D Assertion is false but the Reason is true.

The **narrowly utilitarian** arguments for conserving biodiversity are obvious; humans derive countless direct economic benefits from nature-food (cereals, pulses, fruits), firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes) and products of medicinal importance. More than 25 per cent of the drugs currently sold in the market worldwide are derived from plants and 25,000 species of plants contribute to the traditional medicines used by native peoples around the world. Nobody knows how many more medicinally useful plants there are in tropical rain forests waiting to be explored. With increasing resources put into 'bioprospecting' (exploring molecular, genetic and species-level diversity for products of economic importance), nations endowed with rich biodiversity can expect to reap enormous benefits.

Bio prospecting

Exploring

- Molecular Diversity ✓
- Genetic diversity ✓
- Species level diversity ✓

For
economic
importance

"lungs of earth"

The **broadly utilitarian** argument says that biodiversity plays a major role in many ecosystem services that nature provides. The fast-dwindling **Amazon forest** is estimated to produce, through photosynthesis, 20 per cent of the total oxygen in the earth's atmosphere. Can we put an economic value on this service by nature? You can get some idea by finding out how much your neighborhood hospital spends on a cylinder of oxygen. Pollination (without which plants cannot give us fruits or seeds) is another service, ecosystems provide through pollinators layer – bees, bumblebees, birds and bats. *What will be the costs of accomplishing pollination without help from natural pollinators?* There are other intangible benefits – that we derive from nature–the aesthetic pleasures of walking through thick woods, watching spring flowers in full bloom or waking up to a bulbul's song in the morning. Can we put a price tag on such things?

The **ethical** argument for conserving biodiversity relates to what we owe to millions of plant, animal and microbe species with whom we share this planet. Philosophically or spiritually, we need to realise that every species has an intrinsic value, even if it may not be of current or any economic value to us. We have a moral duty to care for their well-being and pass on our biological legacy in good order to future generations.

Types of Conservation

In-situ Conservation

Methods

Hot spots

Protected areas

- ✓ National parks
- ✓ Sanctuaries
- ✓ Biosphere Reserves
- ✓ Sacred grooves

Ex-situ Conservation

- Botanical Garden ✓
- Zoological Parks ✓✓
- Wildlife Safaris ✓✓
- Seed Banks ✓✓
- Pollen Banks ✓✓
- Gamete Preservation ✓



In-situ Conservation

The plants (flora) and animal (fauna) species are conserved in their natural habitat.

Ex-situ Conservation

Flora and fauna are conserved away from natural habitat by creating their natural habitat - like conditions



In-situ methods

HOT SPOTS

- Areas of very **high species richness**.
- Show **Endemism** - have **Endemic species**.
(species confined only to these areas)
- Hotspots are **under high threat to Extinction**.
- Essential to conserve

Previously
25 Hotspots

Currently
"34 Hotspots"
on earth

Together, constitute
"less than 2%" of total
earth's land area

If all Hotspots are
conserved then
ongoing extinction
can be reduced by
30%

India has **3 Hotspots**

(a) Himalayas ✓

(b) Indo-Burma region ✓ *North-eastern region*

(c) Western ghats-Sri-Lanka



National Parks → 90

1st → Jim Corbett National Park, Uttara Khand

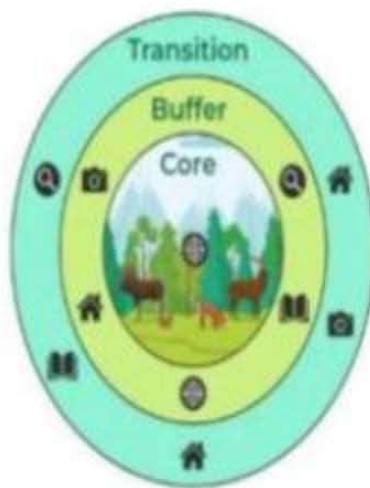
Wildlife Sanctuaries → 448

Biosphere reserves → 14

↓
UNESCO → in 1975

↓
MAB → Man and Biosphere

Zones of Biosphere Reserves



- Biodiversity
- Tourism
- Human Settlement
- Research
- Education
- Monitoring

Buffer → Research and Education

Transition → Local people can have their lands

Core → No activity is allowed



Sacred Grooves

Untouched area protected by local people and sacred to them.

Examples

- (1) **Khasi and Jaintia Hills** in Meghalaya
- (2) **Aravalli Hills** in Rajasthan
- (3) **Chanda, Bastar and Sarguja** region of Madhya Pradesh
- (4) **Western Ghats** Maharashtra and Karnataka.

Sacred Plants:

Tulsi, Peepal

Sacred ~~Lacs~~: *lake*:

Pushkar Lake, Rajasthan

Ex-situ Methods

Botanical Gardens



Protected Areas
“only plants” are
conserved

Zoological Parks



“only Animals” are
conserved

Seed Banks



Endangered
Plants species
seeds are
conserved

Pollen Banks



Cryopreservation

Gametes are
also preserved

-196°C liquid N₂

↓
“Cryopreservation”

In vitro fertilisation



The Earth Summit

1992

Rio de Janeiro
(Brazil)

The world Summit

2002

In Johannesburg,
South Africa

"190 countries"
pledged to
achieve the aim
2010

→ Biodiversity
conservation

→ Sustainable development



- Corbett National Park → Tiger
- Kazi Ranga National Park (Assam) → Rhinoceros
- Ranthambore National Park (Rajasthan) → Lion, Tiger
- Kanha National Park (Madhya Pradesh) → Tiger
- Kanchenjunga National Park (Sikkim) → Snow Leopard
- Periyar Sanctuary (Kerala) → Elephant
- Bandipur National park (Karnataka) → Elephant
- Gir National Park (Gujarat) → Lion

QUESTION

Select incorrect Match:

- A Aravalli hills - Gujarat
- B Khasi and Jaintia Hills – Meghalaya
- C Sarguja – Madhya Pradesh
- D Western Ghats – Karnataka, Maharashtra

QUESTION

Strict protection of biodiversity hotspots could reduce ongoing mass extinctions by almost.

- A 30%
- B 15%
- C 10%
- D 5%

QUESTION

Which of the following statement wrong?

- A stable community show much variation in productivity from year to year
- B According to Tillman's long term ecosystem experiments increased diversity contributed to higher productivity
- C Stable community must be resistant to occasional disturbances
- D Rich biodiversity is essential for ecosystem health but imperative for the very survival of the human race on this planet.

QUESTION

Which one of the following is not observed in biodiversity hotspots?

- A Species richness ✓
- B Endemism ✓
- C Accelerated species loss
- D Lesser inter-specific competition ✓

QUESTION



Assertion: A stable community should show much variation in year to year productivity.
Reason: It must be resilient to occasional disturbance.



- A Both Assertion and Reason are true and Reason is a correct explanation of the Assertion
- B Both Assertion and Reason are true and Reason is not a correct explanation of the Assertion
- C Assertion is true but Reason is false.
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