



Topic 1.1 What is biodiversity?



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European tree frog (*Hyla arborea*).



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Goldmoss sedum (*Sedum acre*).



Forester moth (*Adscita* sp.)

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Balkan green lizard (*Lacerta trilineata*).

biodiversity = biological diversity ► interchangeable terms

it is the variety of life in all of its many manifestations

Definition by the **Convention on Biological Diversity** (Article 2. Use of Terms)

Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Key elements of biodiversity as most often used:

- organismal diversity (or species richness)
- genetic diversity
- ecological diversity (or ecosystem diversity)
 - structural diversity
 - functional diversity



Cyclamen sp.

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Mammoth wasp (*Megascolia maculata*).

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Avicenna viper (*Cerastes vipera*).



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Balkan whip snake (*Hierophis gemonensis*).

Organismal biodiversity

- encompasses the full taxonomic hierarchy from individuals through populations, subspecies, species etc. to kingdoms and domains
- **refers to species richness and species evenness**
 - can be expressed as how many species live on Earth, in Europe, the USA, the Carpathian Basin, the Mediterranean Sea, Hungary, Brussels etc.
 - can also be delimited to certain groups e.g. insects, vascular plants, reptiles or whatever organisms we chose
 - but can be expressed in a more sophisticated way with various diversity indices

Organismal biodiversity

number of species identified on Earth

1,8 million animals, plants, fungi, microbes
 ... but many more need to be identified
 estimations go from 5-100 million species



©SYlvain Ursenbacher

New reptile species from Italy.

Vipera walser Ghielmi, Menegon, Marsden, Laddaga & Ursenbacher, 2016

Number of species currently known to exist in the world		
Mammals	5,513	
Birds	10,425	
Reptiles	10,038	
Amphibians	7,302	
Fishes	32,900	
Total Vertebrates		66,178
Insects	1,000,000	
Spiders and scorpions	102,248	
Molluscs	85,000	
Crustaceans	47,000	
Corals	2,175	
Others	68,827	
Total Invertebrates		1,305,250
Flowering plants (angiosperms)	268,000	
Conifers (gymnosperms)	1,052	
Ferns and horsetails	12,000	
Mosses	16,236	
Red and green algae	10,386	
Total Plants		307,674
Lichens	17,000	
Mushrooms	31,496	
Brown algae	3,127	
Total Others		51,623
TOTAL SPECIES		1,730,725

www.currentresults.com/Environment-Facts/Plants-Animals/number-species.php

single-celled organisms such as bacteria & protists are not included in the table

Organismal biodiversity

new species are regularly discovered

± 13,000 new species are described annually

- 130-160 fish species (Berra 1997)
- 95 amphibian species (Frost 2017)
- 6-87 bird species in resp. 1999 & 2002 (van Rootselaar 1999, 2002)
- 25-30 terrestrial mammal species (Ceballos & Ehrlich 2009)



New frog species from Brazil.
Phyllodytes amadoi Vörös, Dias & Solé 2017

Organismal biodiversity

new species are regularly discovered

[2017 Top 10 new species](#)



©Gábor Csorba

New bat species from SE Asia.
Myotis soror Ruedi, Csorba, Lin & Chou, 2015



©Miguel Angel Peña Estévez, Wikimedia Commons

New bird species from Gran Canaria.
Fringilla polatzeki (Hartert, 1905), recognised as new species for science in 2016



© Antal László

©László Antal

New fish species from the Carpathian Basin, *Barbus biharicus* Antal et al. 2016

Genetic diversity (within species)



DNA chains

©Qimono

- encompasses **the components of the genetic coding** (nucleotides, genes, chromosomes) that structures organisms
- and **variation in the genetic makeup** among individuals within a population and among populations

Genetic diversity (within species)

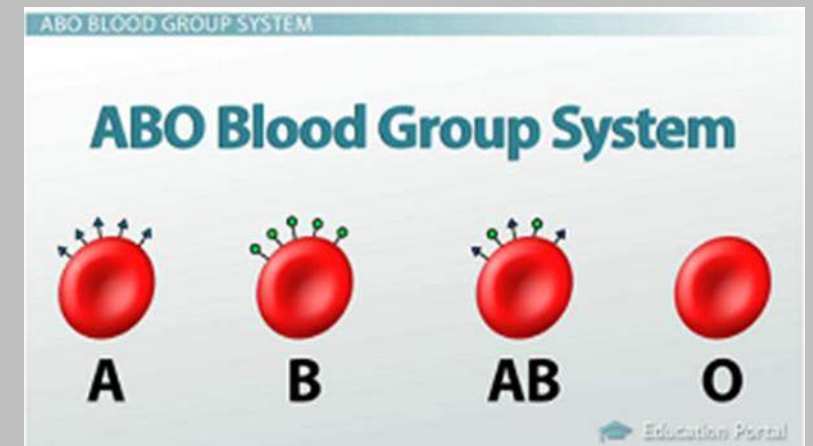


Morphotypes

Human morphotypes are the result of separate phylogenetic histories and of living under different environmental conditions. It is an enormous genetic variation within one species: *Homo sapiens*.

Human blood group system

ABO blood group system indicates genetic variation in humans on a locus that determines the well known blood types in this system.



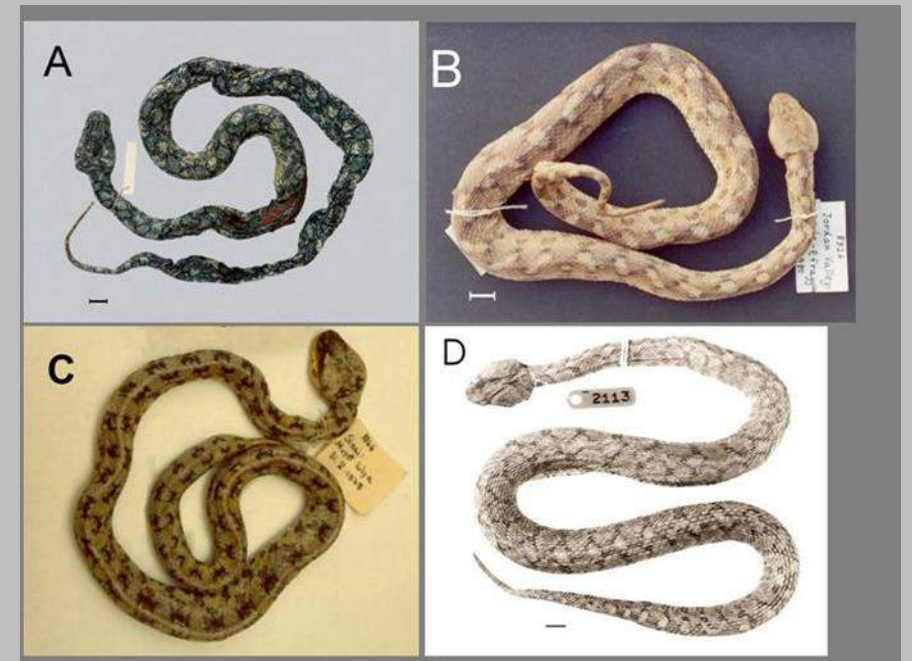
Genetic diversity (within species)

Geographic variation

- species vary along their distribution range as local selective forces also vary
- often manifests in morphology, behaviour etc.
- underlying genetic makeup varies as well

Echis coloratus, a venomous snake, is morphologically highly variable along geographical gradients, from Western Egypt to Eastern Arabia:

A: type specimen of *E. coloratus coloratus*; B: subspecies *E. collaratus terraesanctae*; C: colour morph; D: different species *E. omanensis* based upon analysis of geographic variation.



Genetic diversity (within species)

Polymorphism (poly=multi - morph=form)

The European adder (*Vipera berus*) often shows colour polymorphism within populations. Moreover, males and females differ in coloration (sexual dichromatism). They may be unicoloured (black, red, brown) or zig-zag patterned.



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European adder (*Vipera berus*).



European adder in Romania.

©Tibor Sós

Ecological diversity

- encompasses the scales of ecological differences from populations, through habitats, to ecosystems, ecoregions, provinces, and on up to biomes and biogeographic realms
- is the variation in ecosystems in a region or the variation of ecosystems over the whole planet



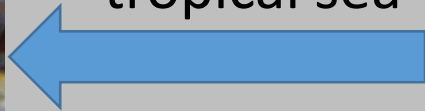
Ecological diversity

- includes structural and functional diversity
 - **structural**: in terms of physical diversity or structural complexity
 - **functional**: the number of functional relationships (interactions) between populations
- important to have a good understanding of how an ecosystem functions

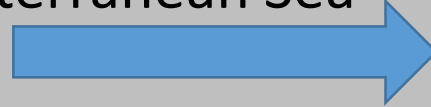
Ecological diversity



Structural diversity
of a coral reef versus a
temperate zone coastal water
tropical sea



Mediterranean Sea



in addition to the structure already
provided by geological processes
(substrate & sea level change),
corals themselves build up a highly
diverse structure allowing for a higher
species richness

Ecological diversity



Structural diversity of a forest

The open canopy of lowland oak forests allows further layers of understory communities, resulting in high species diversity.

[Read more about forest layers!](#)



Closed canopy of a mountain beech forest prevents light breaking through foliage resulting in poor stratification of understory communities, hence species diversity is low.

Ecological diversity



@Timo Tijhof – Wikimedia Commons

Symbiosis (mutualism): clown fish - sea anemone.



@Wikimedia Commons

Symbiosis (parasitism): human – mosquito.

Functional diversity

interactions of organisms in communities and ecosystems

[Watch the video!](#)



@Gergely Babocsay

Predation (herbivory):
hawk moth caterpillar – *Euphorbia*.



@Caelio - Wikimedia Commons

Predation (carnivory): lion – cape buffalo.



@Gergely Babocsay

Symbiosis (mutualism): eryngo – butterfly.

Temporal changes in biodiversity

Biodiversity can be described along a time line:
at a certain point of time or at a period in the present, past or future

▶ **the geologic time scale**

Long term changes: biodiversity in past geological periods

- number and composition of species varied from the appearance of life on Earth till the present
- composition of fauna and flora differed markedly during glacial and interglacial periods

Short term changes in biodiversity

- ecological processes: provide temporal and spatial variability of the environment, causing changes in biodiversity; e.g. succession: composition of the communities change during forest development
- seasonal variation: due to annual animal migration, dormancy, hibernation

Measuring biodiversity

Biological diversity is quantifiable:
there are several indices of diversity used in different biological studies.

Two widely used indices are:

- **Shannon-Wiener diversity index:**

$$H = -\sum p_i \ln p_i$$

where p_i is the proportion of individuals in the i^{th} species

- **Simpson diversity index**

$$Y = \sum p_i^2$$

where p_i is the proportion of individuals in the i^{th} species

See also: http://www.coastalwiki.org/wiki/Measurements_of_biodiversity

Diversity of life should not be valued only for its functional use but also be valued for its own sake.



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Green whip snake (*Hierophis viridiflavus*).



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Poet's daffodil (*Narcissus poeticus*).