

BIOL1906

Biodiversity

Classification systems

Why classify?

Classification systems allow organisms to be named in a logical and universal way, as well as providing an alternative method to determine relationships / ancestral proximity between organisms.

The classification system can be remembered by the acronym **King Philip Can Order Five Good Soups** (Kingdom Phylum Class Order Family Genus Species)

Domains	Monera (Prokaryotes)		Eukarya (Eukaryotes)			
	<ul style="list-style-type: none">No nucleusNo membrane bound organelles		<ul style="list-style-type: none">NucleusMembrane bound organelles			
Kingdoms	Bacteria	Archaea	Protista	Plantae	Fungi	Animalia
	<ul style="list-style-type: none">UnicellularDistinctive cell walls	<ul style="list-style-type: none">UnicellularDistinctive cell walls	<ul style="list-style-type: none">Unicellular or multicellularSome have cell wallsA collection of organisms that do not fit into other kingdoms	<ul style="list-style-type: none">Multicellular land plantsCell walls of celluloseGet energy from the sun	<ul style="list-style-type: none">Most multicellularCell walls of chitinAbsorb molecules from the environment	<ul style="list-style-type: none">MulticellularNo cell wallsIngest other organisms

Named species

There are **1.2 million** scientifically named species however it is estimated that 90% of species are still unnamed/undiscovered. Why? When we try to count species, we encounter problems:

- Inaccessible habitats
- Defining species – what kingdom etc. should they belong to?
- Cryptic species – species that we don't know exist
- Complex life cycles – the same species may incorrectly be given separate names based on the stage they were discovered in, when in fact they are the one species

Relative abundance

Out of all the species, it is estimated that we **know the least about insects** (despite estimations suggesting they are the biggest group), then arachnids, molluscs and crustaceans, whilst we **know the most about mammals**, then birds, reptiles, amphibians and fish.

Types of biodiversity

Biodiversity includes:

- Genetic
- Species
- Landscape
- Community
 - o **Alpha diversity** (local diversity) – the number of different species within a single area at a given time
 - o **Beta diversity** (species turnover) – the difference in composition of species between areas or communities
 - o **Gamma diversity** (regional diversity) – the diversity of a landscape / all areas combined

Darwinian selection

Evolution

Evolution is a process that results in heritable changes in a population.

Fitness – the probability that individuals with certain characteristics will be more likely to reproduce in a population.

Natural selection

Natural selection requires:

- Reproduction
- Heredity
- Variation in characteristics
- Variation in fitness within characteristics

Darwin's (and Wallace's) theory of evolution:

- Theory of evolution by natural selection
 - o More individuals are produced than survive
 - o Variation in 'fitness' exists between individuals
 - o Fitter individuals contribute more offspring
 - o Differences between individuals are inherited

Lamarck's theory of evolution:

- Inheritance of acquired characteristics
- Traits acquired over a lifetime can be passed on

Evolution of the earth

The earth contains a record of its past

We can find out about the history of life by studying **fossils** (moulds, trace fossils and chemical fossils) as well as **dating rocks** (looking at radioactive half-lives and the recorded periodic magnetic reversals of the poles).

For life to exist we need three basic things; **heredity** – a method of passing on genetic information and reproducing, **compartmentalism** – to organise organelles and cells within bodies and **metabolism** – to convert resources into useful products.

Eras in the earth's history

Some of the most important eras in the evolutionary history of earth are:

- Precambrian
 - o Formation of stromatolites
- Cambrian explosion
 - o First signs of modern animals
 - o Resulted in lots of biodiversity
- Ordovician, Silurian, Devonian
 - o Rise in marine life seen -> fish, amphibians
- Carboniferous
 - o Plants colonised the land
 - o Insects diversified
- Permian
 - o BIGGEST EXTINCTION OCCURRED – loss of biodiversity
 - o Drier conditions -> Mammals, reptiles
- Mesozoic era
 - o Dinosaurs appeared
 - o Angiosperms (flowering plants)
 - o Birds and mammals
- Cenozoic
 - o Primates, hominids

Continental drift

Pangea split into Laurasia and Gondwana 200 million years ago during the Mesozoic era.

Wallace's line – coined by Wallace, this line acknowledges the distinct difference between species on either side of this line, suggesting continental drift.

The origin of life (hypotheses)

Abiogenesis – the theory that life originated from inorganic substances

Panspermia – the theory that life originated elsewhere

The big bang occurred 13.75 billion years ago!

It is important to note that knowing the origin of life is not a precondition for evolution.

Macroevolution and major transitions

What is life?

Due to its complexity, life is hard to define. However, the evolution of life has not necessarily led to an increase in complexity as a less complex organism is often more adapted to its environment.

Major transitions such as prokaryotic organisms to eukaryotic organisms did involve a shift in complexity as new ways of transmitting information was developed.

Something is classified as alive if it:

- Is organised – composed of cells
- Utilises metabolism for growth and energy
- Adapts to its environment over time
- Maintains internal homeostasis
- Responds to stimuli i.e. moves
- Can reproduce

Major transitions

Unicellular → multicellular: Cellular life allowed for the **localisation of genes** and ease of **homeostasis**. But **cell division** and **transmembrane transport** were obstacles. Multicellularity allowed for **cell specialisation**, **complex development** and **cell coordination**.

Asexual → sexual reproduction: Increase in **variation**.

Individuals → colonies: Working as a colony increases **efficiency**.

Primate society → human society: Development of **language**, **civility** and an **increase in brain size**.

Species and speciation

What is a species?

The boundaries/definitions of species are often blurry, but multiple concepts have been put forward in an attempt to describe the differences between and similarities within a species.

- **Morphological species concept**
 - Based on the **similarity** within a species, and the **differences** between species
 - Characteristics are easily measured especially with the use of fossils
 - Problems: differences may be due to the **environment** leading to incorrect classification, **cryptic species** (i.e. individuals that are morphologically identical to each other but belong to different species) can be confused as being part of the same species
- **Biological species concept**
 - Based on the assumption that **different species cannot interbreed**
 - This is the **most widely accepted** theory
 - Problems: **difficult to test**, **cannot be applied to asexual organisms**

- **Phylogenetic species concept**
- Defines species as the smallest set of organisms with a common ancestor that can be distinguished from other sets
- **DNA sequences** are usually used
- This concept can deal with asexual organisms, can detect cryptic species, and includes ideas from both concepts
- Problems: genetic analysis is still **costly** and requires **specialist equipment**

Isolation mechanisms

Pre-zygotic and post-zygotic mechanisms are used to prevent hybridisation between species.



Pre-zygotic

Timing of breeding seasons
Different habitats
Different courtship behaviours
Physical differences



Post-zygotic

Hybrids don't reach maturity
Functional gametes cannot be produced
Hybrid breakdown
- offspring of hybrids cannot reproduce

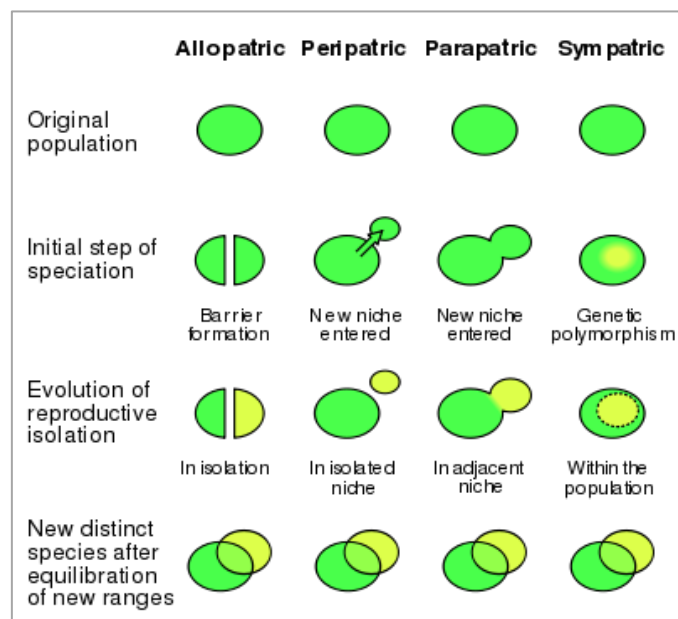
Species formation

Modes of speciation:

- Allopatric
- Parapatric
- Sympatric

Cladogenesis - the formation of a new group of organisms by evolutionary divergence from an ancestral form.

Anagenesis - species formation without branching of the evolutionary line of descent.



Phylogenetics

Phylogenetics/cladistics

The study of evolutionary relationships between species, populations and individuals. It is used for **determining relatives of cultivated species, conservation, and tracking viral evolution.**

Phylogenetic trees