Origin of Species

- **Species** - distinct equities that can exist in one location and show similar relationships - the different species but cannot interbreed.
- **Sympatric (same land) species** - organisms which occur in the same location but don't interbreed with one another - different species, e.g. humans and dogs, humans and gorillas.
- **Behavioural separation** - e.g. Lizards which live in the forest, they are very similar looking organisms and can interbreed but because they live apart from each other they don't interbreed.
- **Hybrid** - the offspring of 2 plants or animals of different species.

Geographic Variation

- One species of snakes but with different appearances.
- If they interbreed they produce offspring which has a mixture of the phenotypes of the parents - when the subspecies interact with one another - intergrades form.
- They look different however if they aren't the same species --> hence interbreed with one another --> they aren't reproductively isolated.

Biological Species Concept - a population of organisms which if they are capable of interbreeding then they are classified as the same species. Fertile reproduction can only happen between the same species.

Reproductive Isolation

- Its one species being prevented from mating with other species. They don't mate with other, but if they do then their offspring is infertile.
  E.g. Tiglons and Blue-footed Boobies.

Pre-zygotic

- Geographically isolated.
- Reproduce at different times of the year.
- Behave differently.
- Gametes cannot get together.

- **Ecological** - the organisms occur in the same general environment but occupy different habitats (different parts) within that environment.
  - Tiglons

- **Behavioural** - they have an elaborate courtship display (dance on their feet to attract).
  - Certain flowers only attract 1 type of insect (e.g. Attract male wasp).

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Other behavioural ways in which organisms attract their mates: sound production (frogs, cicadas and lacewings), visual signals, chemical signals (insects), electrical signals (fish).

- **Temporal isolation** - organisms are only interested and reproductively active at a certain time of the year.
  - Humans and Gorillas are always active.
  - Other animals use seasonal signals.
  - Others will reproduce when they have sufficient resources, e.g. Kangaroos --> even 24 hours after they give birth, only if they have the resources.

- **Mechanical isolation** - the size and structure of the male and female reproductive organs may be incompatible.
  - The male sexual organ is so diverse (lots of variety) that's they are used as a primary basis for distinguishing species.
  - E.g. Bees may carry the pollen of one species on a certain place in their bodies; if this area does not come into contact with the receptive structures of the flowers of another species, the pollen isn't transferred.

- **Prevention of Gamete Fusion** - population occurring between organisms from different species - but not fertilisation.
  - Can't smell where the egg is --> don't know where to swim to.
  - Reproductive environment might be hostile - conditions aren't right for fertilisation to occur - the sperm might perform so poorly that fertilisation never takes place.
  - Egg needs to have the right receptors to accept the sperm.

Post-zygotic

- Mating has occurred (Horses + Donkeys = Mules), but the offspring is infertile.
- They are infertile because they have an odd number of chromosomes - cannot pair up.
- This can happen artificially.

Problem in the Concept

- Reproductive isolation may not always be the case.
- E.g. Leopard Frogs can be brought together and in some they can actually produce fertile offspring --> when brought together they are not reproductively isolated anymore.
- At first hybridisation wasn't seen much but in recent years it has come to Biologists attention that its increasing.
- Plants undergo a lot of hybridisation - 50% of some plants not genetically isolated.
- New evidence now shows that hybridisation isn't all that uncommon in animals either - 10% of birds hybridise in nature.

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Ecological Species Concept

- Distinctions among species are maintained through natural selection.
- When a new allele is introduced to a species' gene pool, they are quickly removed by natural selection.

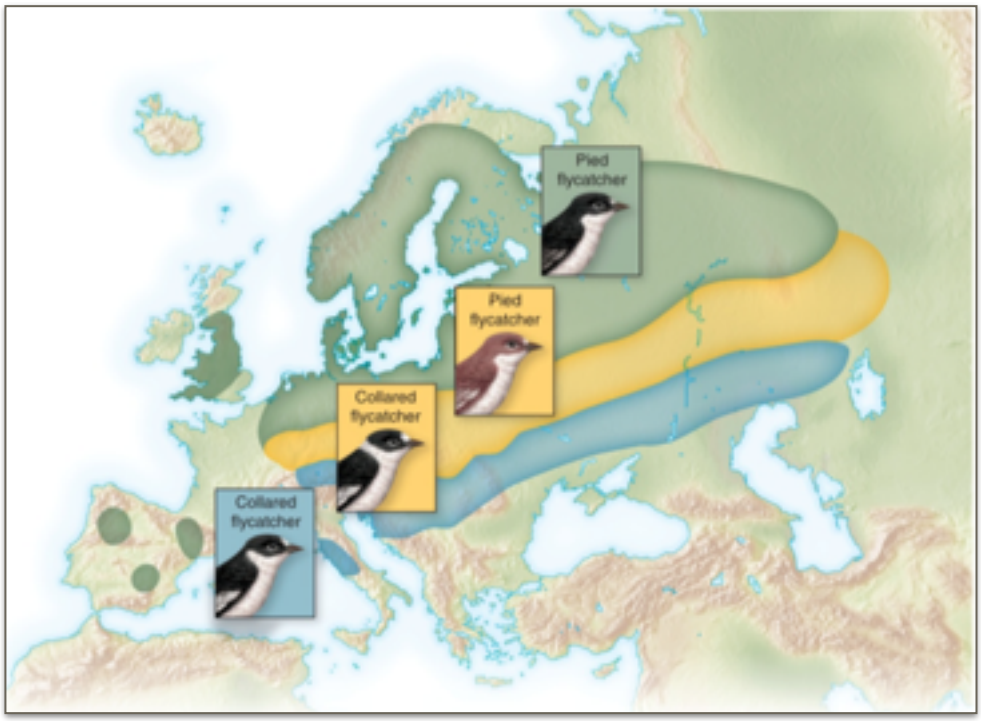
Other Weaknesses

- It is not possible to determine whether individuals will interbreed as they might be geographically isolated - even though experiments can tell us, it's not enough.
- For asexual organisms, reproductive isolation doesn't apply for them.
- There may be no single explanation of or what maintains the identity of species.

- As long as there is reproductive isolation it's possible to maintain species separate from one another.
- If there is no complete reproductive isolation --> reinforcement of the species - wont pass on its alleles to the next generation.
  - Inferior - not attractive to mates.
  - Not as efficient as gathering food or space.
- This allows evolution to occur.

- **Cladogenesis** - start with ancestral species - something happens that divides the species in 2. They become reproductively isolated and distinct species.
  - Happened in horses.

- The Pied flycatcher and the Collard flycatcher look very similar even though they are in different locations. However in places when they occur sympathetically (together but don't interbreed), they have evolved differences which reinforces their differences and makes sure that they avoid hybridising.



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Genetic Drift in Separation

Founder effect or **Bottleneck effect** - only by chance.

- > 1000 different species of Drosophila on Hawaiian Islands.
- Within speciation there are courtship behavioural differences.
- Given time, any 2 isolated populations will diverge because of genetic drift.
- In some cases, this random divergence may affect traits responsible for reproductive isolation, and speciation may occur.

Creating Reproductive Isolation

- First there needs to be a barrier (Geographic, Pre-zygotic, Post-zygotic) - zygote means fertilised egg.
- Those barriers eventually create reproductive isolation - elimination of gene flow, the individuals which were once one species are now different species and will not interbreed.
- **Allopatric** - 2 groups which are in different lands.
- **Sympathetic** - when they live in the same land.

Adaptation in Speciation

- Courtship displays are very important for mating, especially for **Anolis Lizards**, as they have to be able to show off their dewlap to the female in order to mate.
  - Light coloured ones are good in the dark environment - visa-versa.
  - If they move due to population pressures then they are screwed.

Geography of Speciation

- One population can diverge into 2 different species --> they must be in such places that would stop them from having the chance to interbreed with each other.

Only some birds will fly out because its quite far (a). A small stream could separate a population in 2 (b). One part of the trees were wiped out --> speciation (c).
These are all examples of geographic isolation. If they are not isolated then gene flow would keep occurring --> no differences will occur --> remains a single species.

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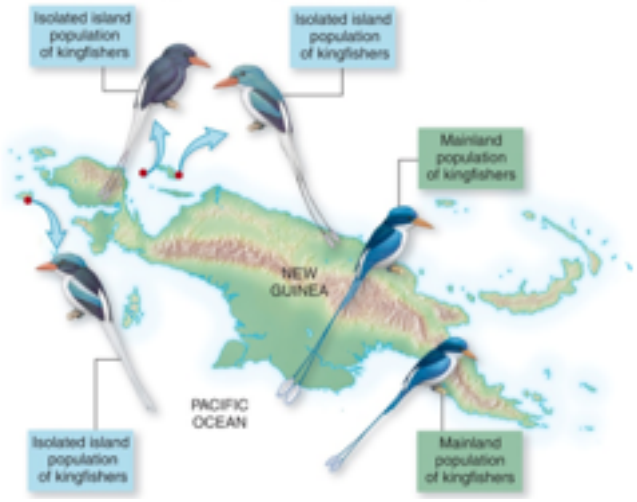
Allopatric Speciation



- Speciation occurring in 2 or more separate locations.
- Kingfishers were once in the mainland and some migrated to different islands:
  - Different species.
  - Phenotypically different.
- Not one homogenous species anymore.
- Now geographically isolated.

Sympatric Speciation

- All the organisms are in the one location, so why does speciation occur?
- Their barrier is in their genetics --> they have a different number of chromosomes, hence unable to produce viable (capable of working successfully) hybrids if they do mate.
- **Polyploid** - having multiple sets of chromosomes. (Humans are diploid = 2 chromosomes).
  - If chromosomes are an even number --> more likely to produce fertile offspring.
  - If chromosomes are an odd number --> less likely to produce fertile offspring.

- **Autopolyploidy** - chromosomes may arise from a single species. (May come from an error in the doubling of chromosomes).
- **Allopolyploidy** - chromosomes from 2 species hybridise.
  - The resulting offspring having one copy of the chromosomes of the species is usually infertile because the chromosome do not pair correctly in meiosis. However such individuals are often otherwise healthy, can reproduce asexually, and can even become fertile through a variety of events. For example if the chromosomes of such an individual were to spontaneously double, the resulting tetrapods would have 2 copies of each set of chromosomes. Consequently, pairing would no longer be a problem in meiosis. As a result, such tetrapods would be able to interbreed and a new species would have been created.

- **Disruptive selection** - only some phenotypes get to reproduce.
  - The Chiclid fishes in Lake Barombi Mbo in Cameroon: there are 11 different species which are closely related to each other compared to the other species in other lakes. They have interbred.
  - If disruptive selection didn't occur --> there would be a lot of variation within the population - all interbreeding.

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