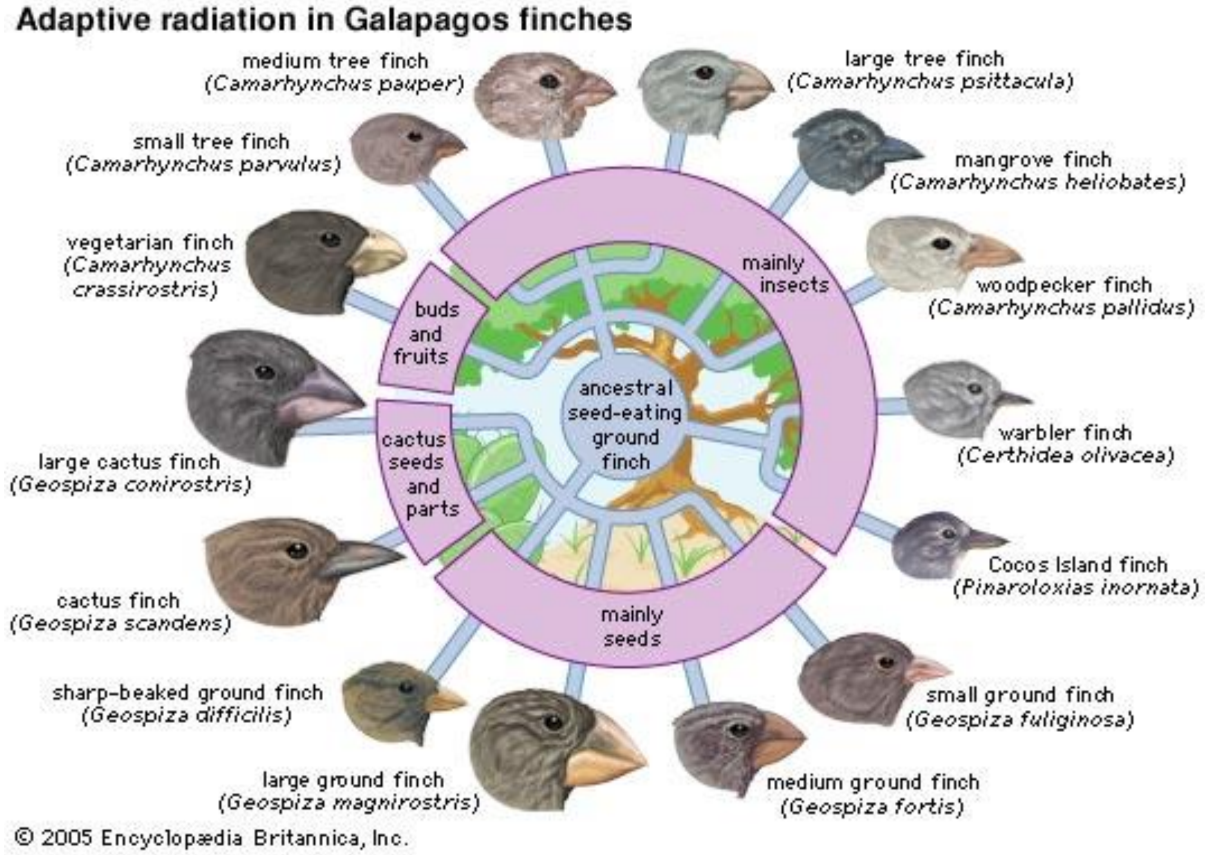
Patterns of Evolution

Adaptive Radiation

- Adaptive radiation is an increase in the morphological (what they look like) and ecological (where they live) diversity of a species eventually resulting in the formation of new species.

Adaptive Radiation

- It usually occurs very rapidly when a species colonizes a new environment (Darwin's Finches) OR by survivors after a massive extinction event (Mammals after the extinction of the Dinosaurs).



Adaptive Radiation

- **Darwin's Finches**: An ancestral finch population got blown off the mainland of South America onto the Galapagos Islands. Over time that finch species evolved to fulfill all the niches on the islands and thereby give rise to the variety of finches seen on the islands.
- **Mammals after the extinction of the Dinosaurs**: With Dinosaurs out of the way, mammals were able to grow bigger and fill all the niches vacated by the larger reptiles, which explains the wide diversity of forms we see in mammals today.

Adaptive Radiation

- It supports evolution by showing that groups of organisms (i.e. mammals) are all related to each other and came from a common ancestor that inhabited new environments and evolved to adapt to these environments.

- All mammalian forelimbs contain the same bones which shows that they all evolved from a common ancestor.

Divergent and Convergent Evolution

- **Divergent**
  - Species that were once similar diverge or become increasingly distinct
  - Eg/ Darwin's finches

- **Convergent**
  - A pattern of evolution in which similar traits arise because different species have independently adapted to similar environmental conditions
  - Eg/ bats and birds

CONVERGENT EVOLUTION

- **Species** from different **evolutionary branches** may come to resemble one another if they live in **very similar environments.**

- **Example:**

  1. Sidewinder (Mojave Desert) and
  Horned Viper (Middle East Desert)

CONVERGENT EVOLUTION - EXAMPLE

- **1. Ostrich (Africa) and Emu (Australia).**

Macroevolution

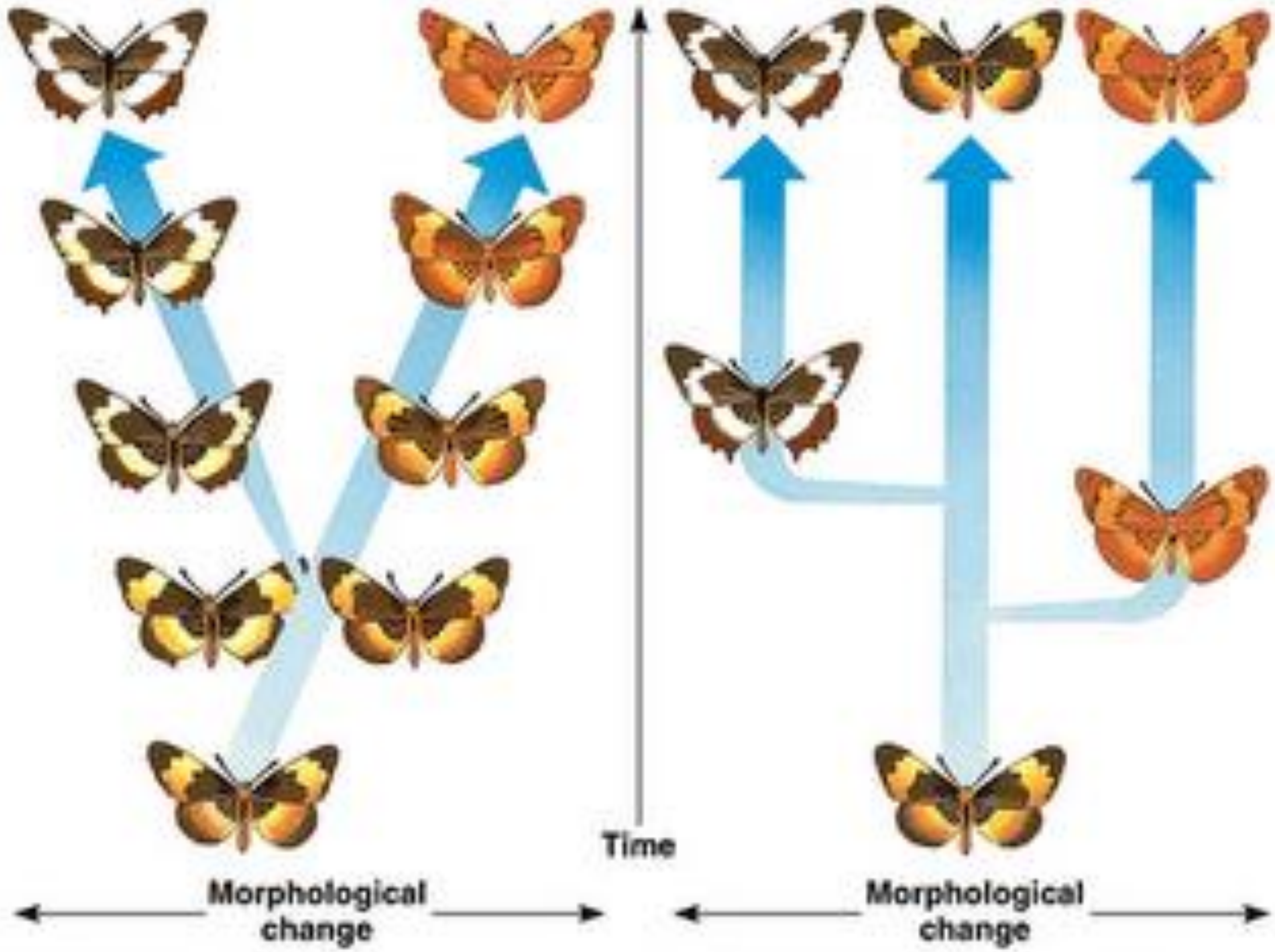
- **Large scale evolutionary change** significant enough to warrant the **classification of groups into genera or even higher-taxa level.**
- For example
  - the separation of eubacteria and archaebacteria.
  - **Cambrian explosion** – rapid speciation and diversification in the animal kingdom for about 40 million years starting 565 mya. Early arthropods, echinoderms, molluscs, primitive chordates
    - Burgess Shale in B.C.
- 2 major theories for macroevolution / the rate of evolution:

Theory of Gradualism

- **The accumulation of many small and ongoing changes and processes**.
  - When new species first evolve, they appear very similar to the originator species and only become more distinctive, as **natural selection and genetic drift act** on both species.
  - One would expect then to find many **transitional species** in the fossil record.
  - This is explained by an **incomplete fossil record**, and the possibility that intermediate forms were not preserved.

Theory of Punctuated Equilibrium

- Eldredge and Gould (1972) rejected the explanation of the incomplete fossil record and proposed the **Theory of Punctuated Equilibrium**
- **Relatively rapid spurts of change followed by long periods of little or no change.**
  - Species **evolve very rapidly** in evolutionary time
  - Speciation usually occurs in **small isolated populations** and thus **intermediate fossils** (transitional species) are **very rare**.
  - After the initial burst of evolution, species **do not change significantly over long periods of time.**



(a) Gradualism model
(b) Punctuated equilibrium model

Which one do we use today?

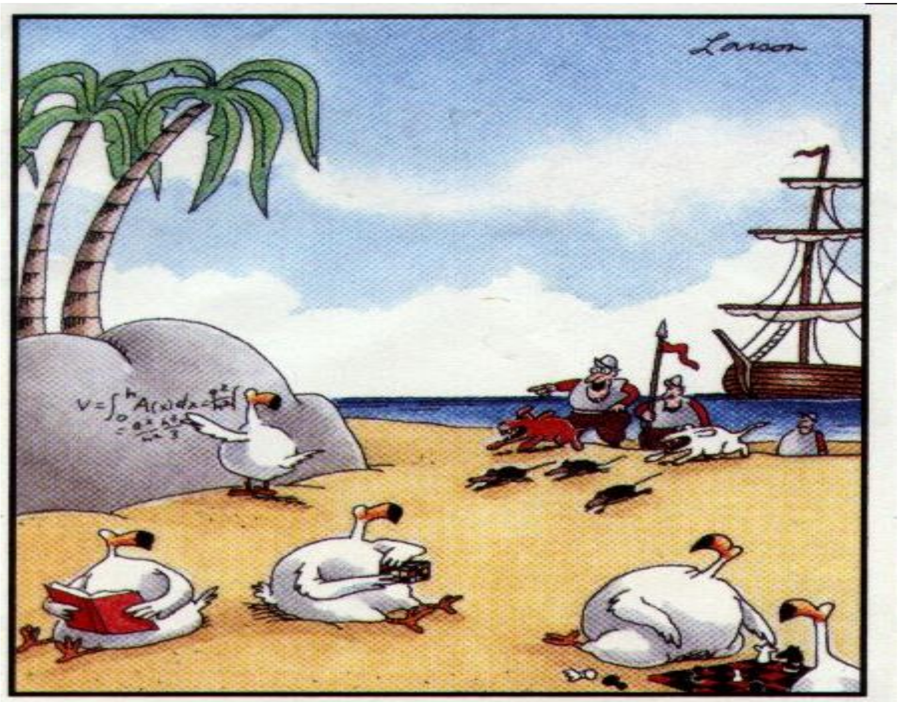
- Today **both theories** are needed to understand the fossil record.
- It is widely accepted that both gradual and rapid evolutionary processes are at work.
- Example:
  - Before a major extinction event, an environment may be host to many well adapted species and evolutionary change would be slow.
  - An environmental crisis resulting in extinction of many species would leave many niches empty.
  - Surviving species have many new opportunities and experience disruptive selection, evolving into many species which fill the niches.
  - Once they become well adapted, stabilizing selection kicks in again and more gradual change occurs.

Consequences of Human Activities

- Human-made barriers may prevent gene flow between the split populations
- Isolated populations may undergo adaptive radiation
- Severely fragmented populations may eventually die out if there is insufficient genetic diversity
- E.g. giant panda in China

Speciation and Mass Extinctions

- Five major mass extinctions have been identified



Unbeknownst to most ornithologists, the dodo was actually a very advanced species, living alone quite peacefully until, in the 17th century, it was annihilated by men, rats, and dogs. As usual.