Chan's ENVS200 Review

Chapter 2 - Ecology's Evolutionary Backdrop

EVOLUTION BY NATURAL SELECTION

- Darwin sailed on the H.M.S. Beagle (1831 - 1836) recording and collecting specimens
  - Natural diversity is the result of natural selection (favouring particular variants of species)
- Wallace was influenced by Darwin's publications
- Presented their findings together at a meeting of the Linnean Society in London
- Published *On the Origin of Species* in 1859
- Both members influenced by Thomas Malthus's *An Essay on the Principle of Population* (1798)
- Darwin realized if all offspring lived, species growth would be so great the earth wouldn't be able to handle the load anymore
  - Most individuals die before they are able to reproduce
- Established truths
  - Individuals are not identical
  - Some of that variation is genetically heritable
  - Each living generation is a subset of the ones that may have been alive (killed, died from disease, etc.)
  - Individuals do not contribute equally to subsequent generations (some individuals have more children than others)
- Evolution is, as such, the change over time in heritable characteristics of a population or species
- The individuals who contribute the most were
  - Best able to survive risks/hazards of the environment
  - Most capable of successful reproduction
- Since variation is random, natural selection is a result of random factors, no actual *selection* involved

EVOLUTION WITHIN SPECIES

- Characteristics of a population will only diverge IF
  - there is sufficient heritable variation AND
  - if divergent selection > mixing and hybridization (offspring sharing characteristics of both parents)
- ex. "High elevation" sapphire rockcress are less drought-tolerant than "Low-elevation" sapphire rockcress
- The "common garden" method puts two separate species into the same environment to see how well they do in comparison to each other
- ex. Scandinavian frogs exhibit countergradient variation - variations that let them handle environmental conditions
  - Similar development rates despite latitude variation
  - Without counter gradient variation, high-latitude frogs (ones that live in colder climates) would develop considerably slower than low-latitude frogs
- "Local" adaptation exists, but the extent to HOW local varies depending on the species in question

- Some will show local adaptations in the same area, some will be similar until you compare specimens that originate from thousands of kilometers apart
- "Reciprocal transplant" test takes a specimen and compares how it grows "away" versus "at home"
  - Usually only able to be done with things that won't run away like anemones
  - Generally things grow better at home, but not always
- Adaptations also exist for predation as the method of selection
  - Trinidadian guppies are more flamboyantly coloured the less predation there is
  - Black (melanic) moths are less eaten in pollution-heavy environments while at the same time being more eaten in less polluted environments

ECOLOGY OF SPECIATION

- In a broad sense, things are different species if they can't make offspring together (this test of species specifically gives rise to biospecies)
- Two parts of a population can only evolve into distinct species IF there is some barrier to gene flow between the two parts
  - If they can hybridize, then natural selection can't really make them distinct
- Ecological speciation consists of two parts:
  - Ecological source of divergent selection
  - Means of reproductive isolation
- Stages of ecological speciation
  - Allopatric stage - geographic isolation of two parts of a population
  - Secondary contact - populations meet up again but hybrid offspring aren't as good/as reproductively fit as non-mixed offspring
  - Sympatric stage - two completely distinct species now exist in the same place
- Doesn't always follow these steps exactly
  - ex. Island species are separated geographically, and then never have secondary contact again, and therefore never enter the sympatric stage
  - ex. Darwin's finches (different types of originally the same bird with different beaks split up by islands) are an example of allopatric speciation
- Island endemics are species that only exist in one island or one specific area
- Ring species - species with variants along a geographic gradient
  - Neighbours can usually breed okay with each other, but not with neighbours "across" the "ring"
- Sympatric speciation also can occur - two types of fish (cichlid fish) evolved from the same type in a volcanic crater, one specialized to be top-feeding, one specialized to be bottom-feeding
  - No geographic separation occurred

EFFECT OF CLIMATE CHANGE

- For the past 2-3 million years, the earth has been pretty cold
- Temperature goes in cycles (glacial cycles) of ~125k years
- Trees and vegetation expanded into the space that the glaciers retreated from
  - Obviously animals can't expand faster than the plants they need to feed on, so it's possibly wrong to assume that we're at some sort of "equilibrium" right no
  - Animals might still be "catching up" to the expansion of vegetation
- In more tropical regions where there weren't any glaciers, it's theorized that tropical trees limited themselves to small areas
  - These "hotspots" of stability are where there is a great diversity in species

- Human-caused global warming is ~100 times faster than regular cyclic warming

CONTINENTAL DRIFT

- Drift of landmasses explains many strange distributions of species
- Parallel evolution is when species develop some of the same characteristics despite being in different places
  - ex. ground hog (placental) vs. wombats (marsupial)
- An analogous structure is something that looks the same or performs the same function BUT was not from a common ancestor (bird wings vs. bat wings)
  - This process of evolving to the same thing without a common ancestor is called convergent evolution
- A homologous structure is something that looks the same or performs the same function AND was derived from a common ancestor