

## Species selection

Traits that arise via microevolution can also act to increase net speciation rate ( = Speciation rate – Extinction rate). Traits that increase speciation rate and/or decrease extinction rate in a clade of species can be identified through comparison of closely related clades, especially if trait arises repeatedly and is consistently associated with high species diversity in those clades relative to sister clades that lack this trait (see Figure from Rabosky & McCune 2010).


The power of species selection, relative to individual-based selection within species, is clearest when traits that are disadvantageous within species are associated with increased net speciation among clades – ie. opposing effects.

Example – evolution of self-compatibility (SC; ability to self-fertilize) in monoecious plants vs, self-incompatibility (SI, no self fertilization). SI can be a disadvantage within species if pollinators are limiting - in this circumstance, SC allows reproduction. But in the longer-term SC increased rate of inbreeding, loss of genetic diversity etc => higher extinction rates. SC has arisen repeatedly in flowering plants (eg. Figure for Solanaceae (tomatoes & relatives)), but analysis of phylogenies suggest that it leads to higher extinction rates of species, despite short-term advantage to individuals. Thus, clades with SI have more species surviving than those with SC.

## The fossil record: transitional forms

Comparison of extant (living forms) => predictions of evolutionarily transitional phenotypes in the fossil record

## Major Transitions in Phenotypes

e.g. Vertebrate Fish  Amphibian Tetrapods

[see next page]

Biology 1B – Evolution Lecture 12 – species selection (macroevol), transitional forms, evolution of novel phenotypes

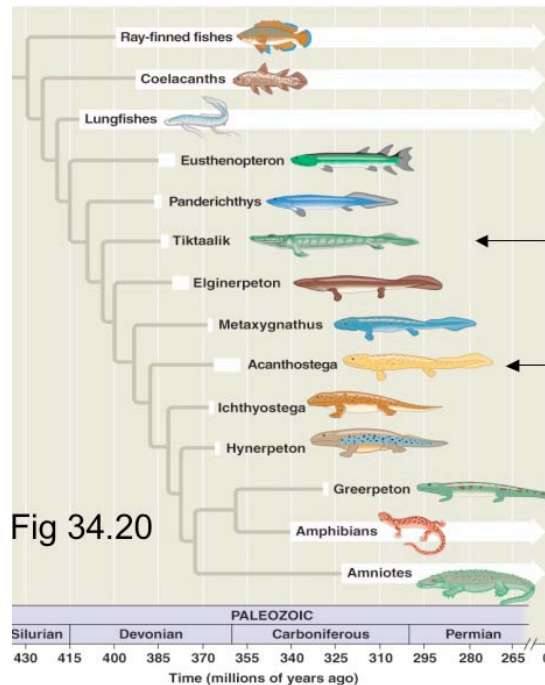
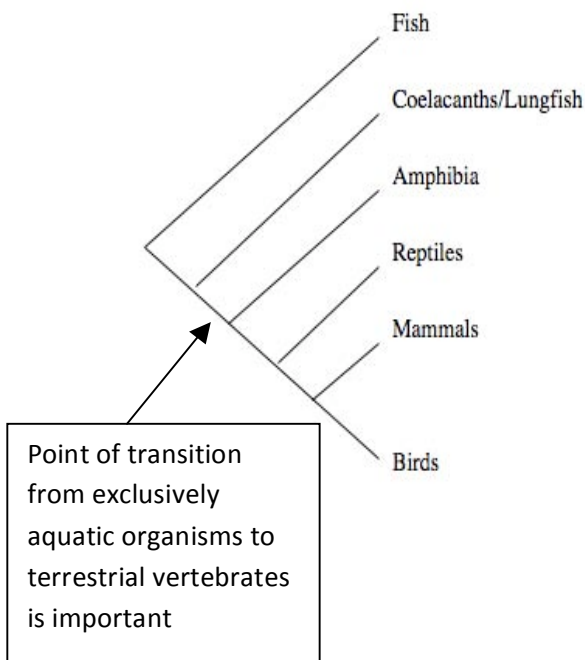


Figure 34.20 (page 711, 8<sup>th</sup> edition)

- There is a huge jump between these groups (particularly in phenotypes), which cannot be constructed from modern fauna—this is where the fossil record comes into play
- The transition from ancestors of lungfish to ancestors of tetrapods, and key insights are coming from fossils
  - Acanthostega has a moving neck, lungs, limbs, but no wrists and a weak rib cage that would have made breathing on land very difficult, so it probably lived in a swamp
  - Tiktaalik, however, has the evolved traits of Acanthostega plus wrists and a stronger rib cage (see image below)
- The extinct forms are not necessarily direct ancestors, but they do allow us to see how and when certain traits/adaptations evolved

## Evolution of Novel Structures and Exaptation

- The hammer and anvil bones of the middle ear of mammals that act as transmitters from the outer ear into the inner ear
- There is a complete set of fossil transitions that takes us from the original function of the bones (articulation points of the jaw) in cynodonts and synapsids

Biology 1B – Evolution Lecture 12 – species selection (macroevol), transitional forms, evolution of novel phenotypes

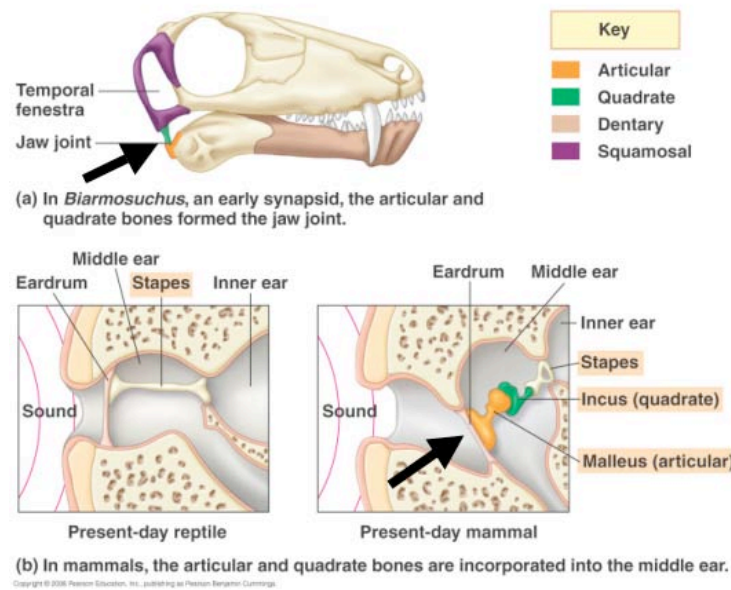


Figure 34.31 (page 721, 8<sup>th</sup> edition), see also Figure 25.6 (page 513, 8<sup>th</sup> edition)

- Co-opting structures from one function to another is known as **exaptation** (don't need a new structure to arise, can simply modify an existing one)
- Feathers are another example—their original purpose may not have been for flight, but rather for attracting mates or thermoregulation  
--new studies have found dinosaurs with feathers that were colored, but not for flight, suggesting their use in display

### Evolutionary Novelties—evo-devo

- Re-programming of developmental pathways can cause changes in timing/location of expression of key regulatory genes
- Within sets of genes, there are often duplicates, allowing one copy to be kept and others to be used for new functions

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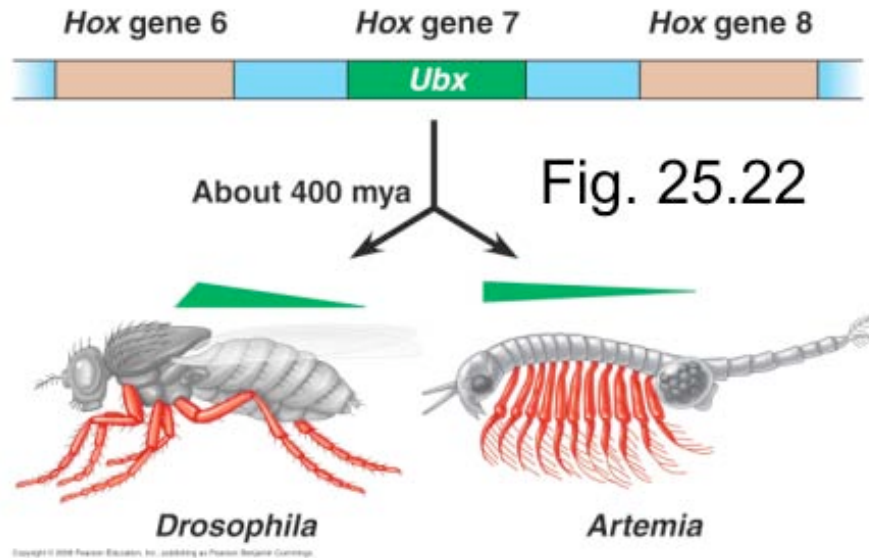
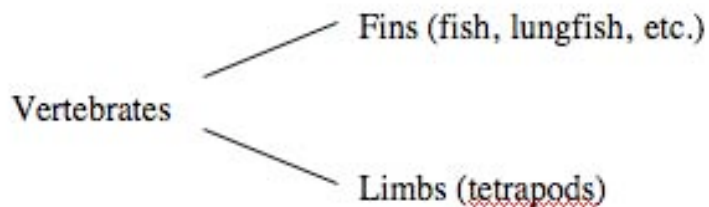


Figure 25.22 (page 527, 8<sup>th</sup> edition)

- In insects, the *Ubx* gene suppresses leg development to 6 legs, but it can have a different effect in other species
- Very different, but homologous structures typically have a common site of developmental genes



These structures have very different anatomy, yet they have similar patterns of *Hox* gene expression