Bio1B Evolution 11

Last lecture:
Species & speciation
• Hybridization - hybrid zones, reinforcement & hybrid-speciation

Today
MACROEVOLUTION
• The fossil record & background extinction
• Mass extinctions - the Cretaceous/Paleogene (“K/T”) boundary - cause & consequence

Transitional forms
• Terrestrial vertebrates (tetrapods)
• Birds & evolution of feathers

Evolution of development programs [Text Pp. 525-530]
• The eye, vertebrate limbs
The fossil record: billions of years of sedimentation => recoverable history

- E.g. Grand Canyon & environs - layered sediments from recent to pre-Cambrian

Fig. 22.3

Fig. 25.5
Major transitions in earth history

- Earliest prokaryotes - fossil stomatolites 3.5 Bya
- Increase $O_2$ - 2.7 Mya
- Fossil eukaryotes 2.1Bya; multicell algae 1.2 Bya
- Complex metazoa 0.55 Bya
- Marine -> land 0.5 Bya
- [Hominids only 0.005 Bya]
The Cambrian “explosion” - Burgess shale & appearance of modern phyla

Fig. 25.10

Burgess shale

“Hallucigenia”

Weird stuff...
The big 5 mass extinctions

- Evidence from analyses of extinction (red) and blues (diversity) or families of marine invertebrates
- Permian-Triassic - 96% species extinction, 8/27 orders of insects; Volcanism in Siberia?
- Cretaceous-Paleogene (“K/T”), 65 Myr - demise of dinosaurs & large terrestrial animals => mammalian radiation
The asteroid impact hypothesis - Luiz & Walter Alvarez, UC Berkeley
(see Science, 5th March, p1214)

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<th>Period</th>
<th>Age (Ma)</th>
<th>Fauna and Flora</th>
<th>Geochemistry and mineralogy</th>
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Faunal turnover Carbon cycle change Iridium spike

The real reason dinosaurs became extinct
Are we the cause of the 6th mass extinction?  (Barnosky et al. Nature 2011)
Understanding the transition of tetrapod vertebrates from water to land

Fig 34.20

Tiktaalik
Acanthostega
Modification of existing structures for new purposes: ears and feathers

Feathers:
for display or warmth before flight?

Late Jurassic feathered dinosaur

Recent discovery: dinosaur feathers were colored - display?

Fig. 34.31. Bones of inner ear of modern mammals are derived from jaw joint of ancestors (see also Fig. 25.6)
Evolution of developmental genes => phenotypic novelty

- Molecular homology: genes with common ancestry controlling development (top right)
- Changes in timing and spatial pattern of expression => change in phenotype
- E.g Ubx suppresses leg development in flies, but not shrimp
Origin of novelties: The vertebrate limb

- Are the fish “fin” and vertebrate “limb” homologous?
- Very different anatomy, yet...
- Similar patterns of Hox gene expression
- Anatomic differences could be due to modification of timing/duration of expression?

Origin of novelty: The eye

Convergent evolution or descent with modification?

Molecular homology of key genes - Pax-6 & opsin pathway

Subsequent modification of pathways and structures