L28-Evolution in Geological Time+Micro/Macroevolution

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Fossils

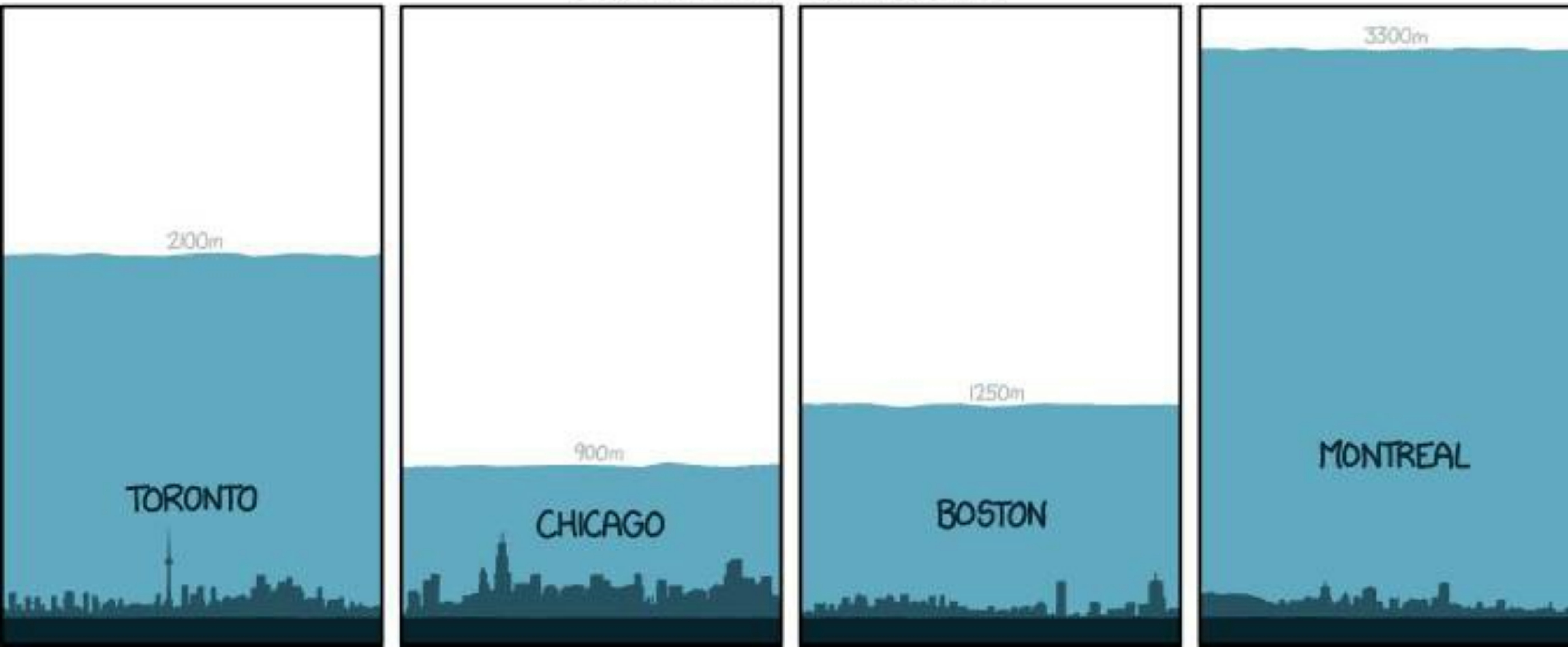
fossil: remains of an organism from an earlier geologic period that are naturally preserved

The study of fossils

paleontology
"old – beings – study"
-integration of disciplines that seek to use fossils to explain biotic forms and abiotic conditions
prior to, but including, the Holocene (12Ky-now)

paleobotany (plants), micropaleontology, in/vertebrate paleontology, paleoanthropology (prehistoric and protohuman fossils), ichnology (tracks), paleoecology

THICKNESS OF THE ICE SHEETS
AT VARIOUS LOCATIONS
21,000 YEARS AGO
COMPARED WITH MODERN SKYLINES



The study of fossils

fossil: remains of an organism from an earlier geologic period that are naturally preserved

paleontology: integration of disciplines that seek to use fossils to explain biotic forms and abiotic conditions prior to, but including, the Holocene (12Ky-now)

geology: study of the solid Earth, its composition and the processes shaping it



Constructing the fossil record

Can show either a progression of complexity or conservation of form

Some organisms that were common are now extinct

Extant genera can resemble (but not always) fossils in young rock, which themselves can resemble fossils in older rock

17th century discovery of fossil sharks tooth shows striking similarity to the teeth of extant forms

THINK-PAIR-SHARE (graded)

Groups of no more than four (4) people
--pick a scribe to write and send email
--include full names on one line
example: Zakee Sabree, David Salazar, Matt Holden, Paul Larsen

Email your answer to sabree.8@osu.edu
--Scribe should send email
--Subject heading must include “MINUTE”

Emails received after 11:30AM will be deleted.

YOU HAVE 10 MINUTES

THINK-PAIR-SHARE (graded)

1) Briefly explain why, if hybrids have reduced fitness, heterogametic sexes will be under strong negative selection. (25 words or less)

2) What do you think it means when a species is called a “living fossil” and give an example? (25 word or less)

Groups of no more than four (4) people
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Email your answer to sabree.8@osu.edu
--Subject heading must include “MINUTE_PAPER”
Emails received after 11:30AM will be deleted.
--pick a scribe to write and send email

YOU HAVE 10 MINUTES

Taphonomy: study of fossils

Amber and freezing: least altered, but rare
-preserved hair, skin, DNA (40,000 y.o. wooly mammoths)
>20,000 y.o. dung from desert caves – 2,000 y.o. human cadavers in peat bogs

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Permineralization and replacement: dissolved external minerals replace native minerals
-petrified wood, dinosaur skulls

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-petrified wood, dinosaur skulls

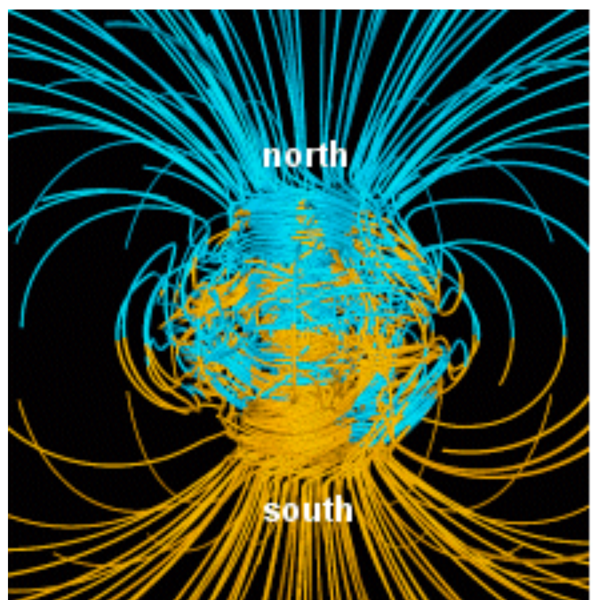
Natural molds (unfilled spaces) **and casts** (filled spaces, replacement of decayed material)
-no internal details provided

Trace fossils: record behaviors rather than form
-footprints, feces, residences (burrows and dens)
-difficult to link with the animal

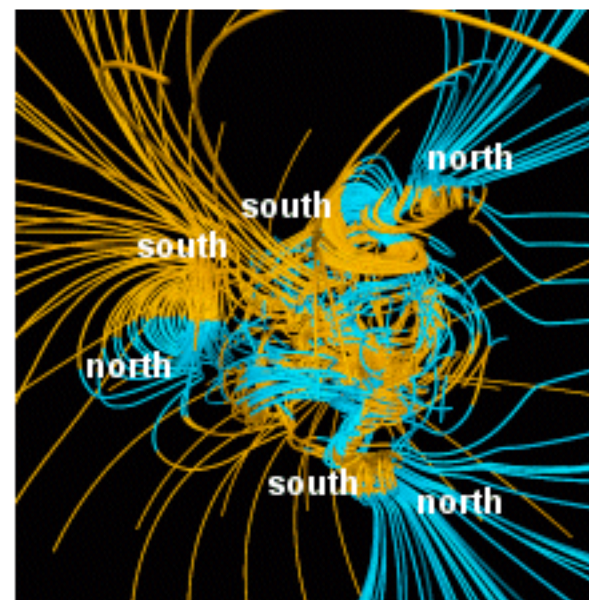
Taphonomy: study of fossils

Radiocarbon dating (Willard Libby, 1949)
- 14C -> 12C decay at a fixed rate (5,730 y)
- 40K -> 40Ar decay 1.3 By is used to date igneous rock

Paleomagnetic dating: alignment of metal particles in substrate (when the substrate was motile)
-multiple geomagnetic shifts throughout time
-many hypothesized causes but not many known effects of geomagnetic shifts



between reversals



during a reversal

Bias in fossil record

Hard parts preserve best

Common species have better chance of being fossilized

Burrowing animals vs. land-dwellers

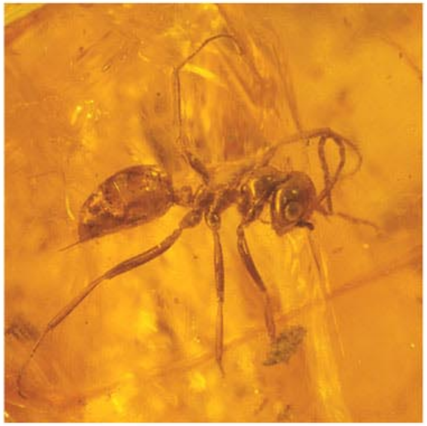
Availability of fossiliferous rock: sedimentary

Locations of collection sites: Europe and North America
-undersea and tropical rain forest present abiotic challenges to collection
-anthropogenic limitations (war)

Conspicuous forms (dinosaurs) are better represented.

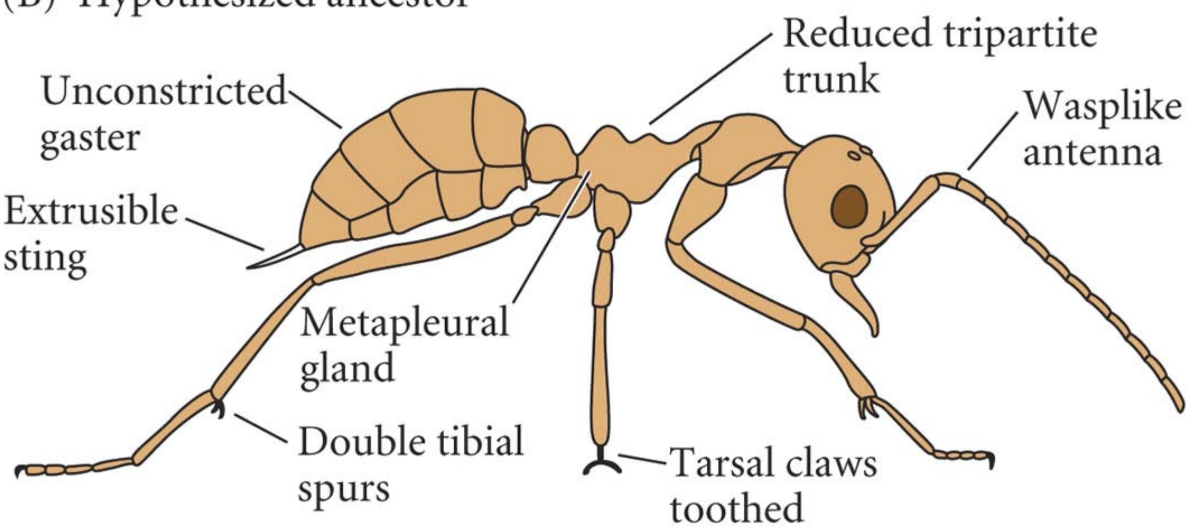
Transitional Forms

(A) *Sphecomyrma freyi*



100 mya

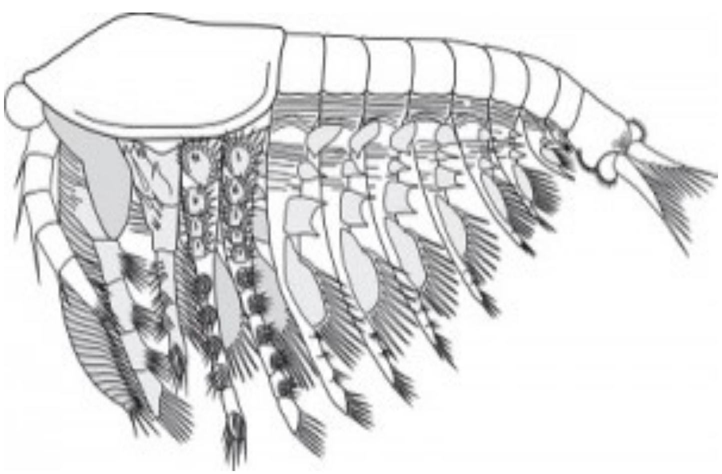
(B) Hypothesized ancestor

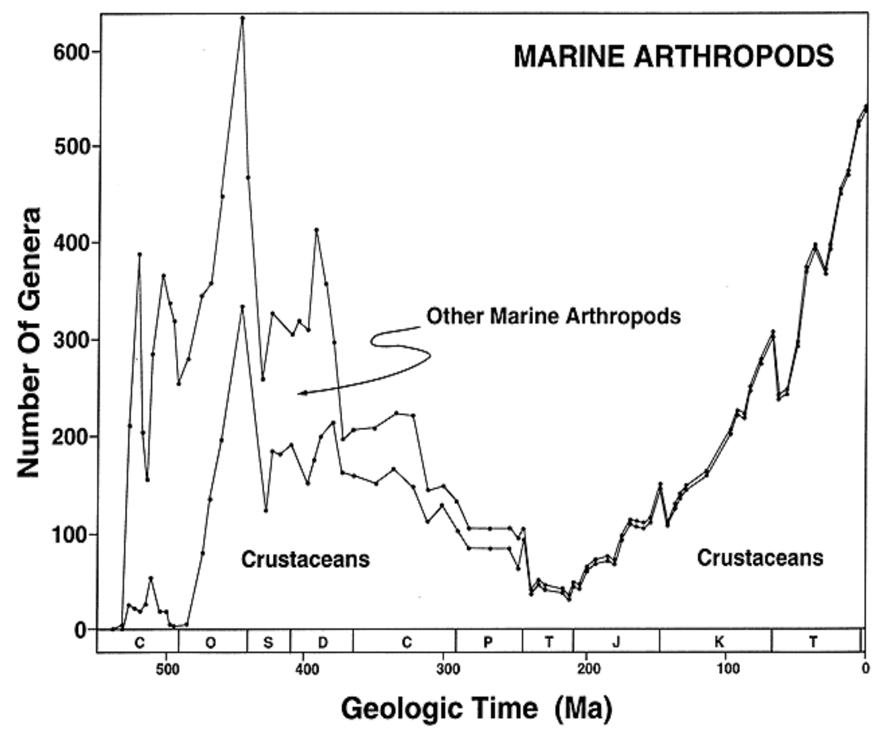


Cretaceous amber fossils represent a transition between ants and wasps

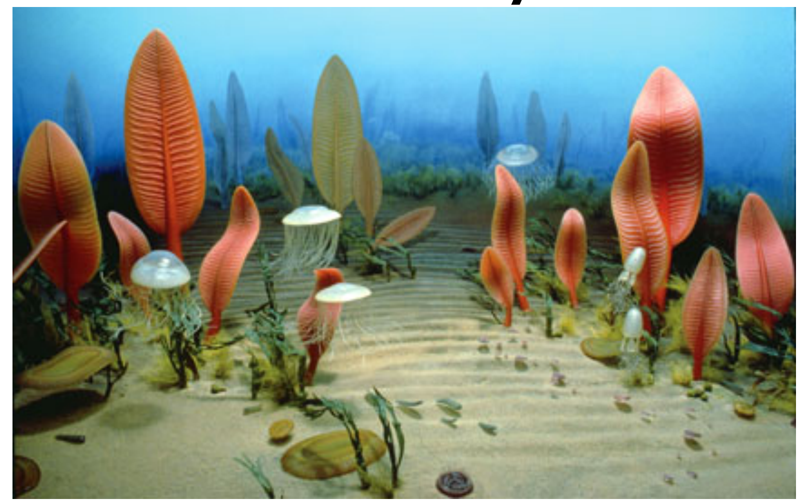
"Pull of the recent"

- Patterns are harder to detect clearly the farther in the past you go
  - Organisms harder to interpret
  - Record more fragmentary





Ediacaran Biota-565 Mya



Ediacaran Biota-565 Mya

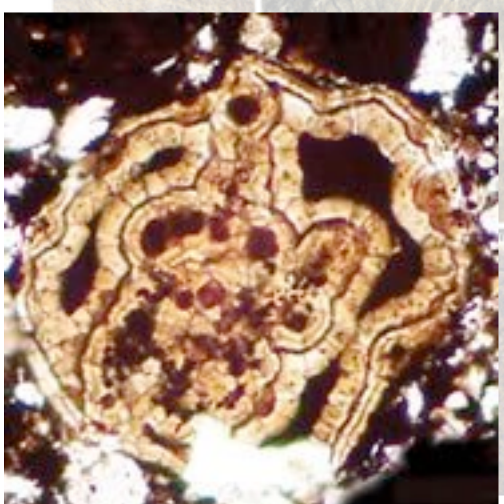
First evidence for macroscopic life in 20 worldwide sites

Impressions (molds and casts) of marine life

Generally small forms (a few centimeters)

Greatest species diversity was aquatic

Detection of mollusks (*Kimberella*) fossils suggest pre-Cambrian bilaterians



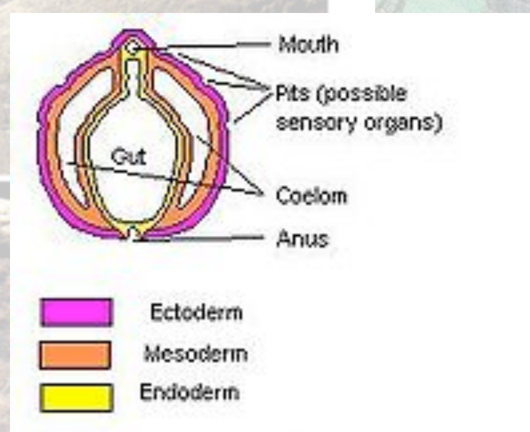


Diagram of the body structire of a Vernanimalcula

Cambrian Biota-~540 Mya

Cambrian Biota-~540 Mya

Burgess Shale (British Columbia) is a rich source of Late Cambrian biodiversity (and oil!)

Preservation of lots of soft-bodied animals

Larger body forms, segmentation, external skeletons, different trophic behaviors (hunting)

Many ancestral forms of extant arthropods, mollusks, verts and echidnoderms present -trilobites, jawless chordates

Diversity during Cambrian period similar to that observed today

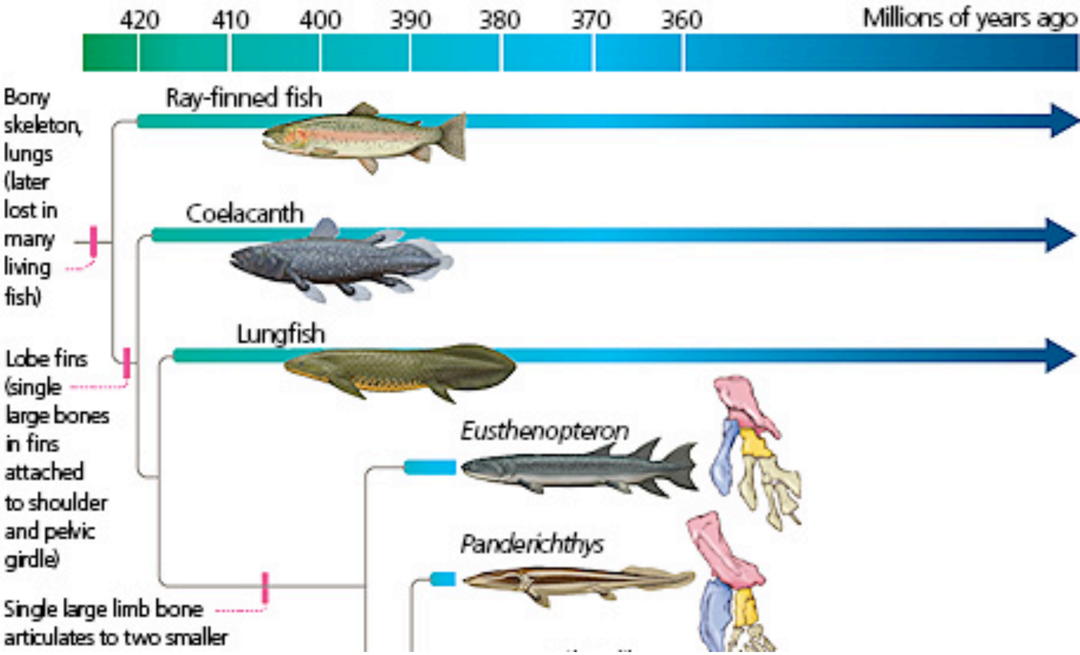
Knoll and Carroll posited that elevated oxygen levels and a pre-Cambrian extinction facilitated the emergence of new forms

Tetrapods ('four feet)

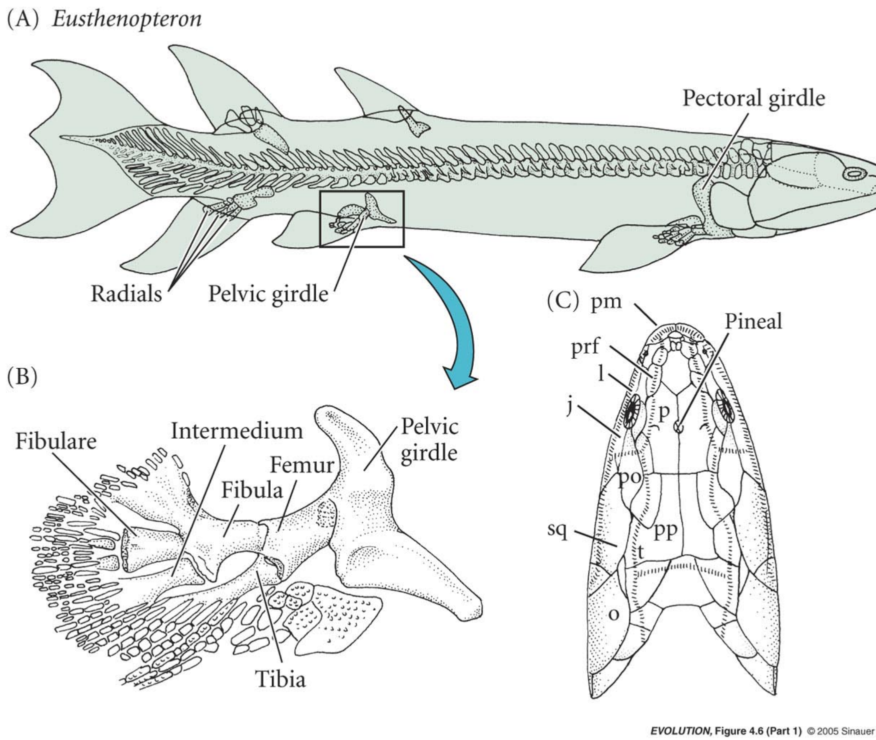
Lobe-finned fishes (Sarcopterygii)

-Devonian (408 Mya)

-lungfishes and coelacanths (some are still around)

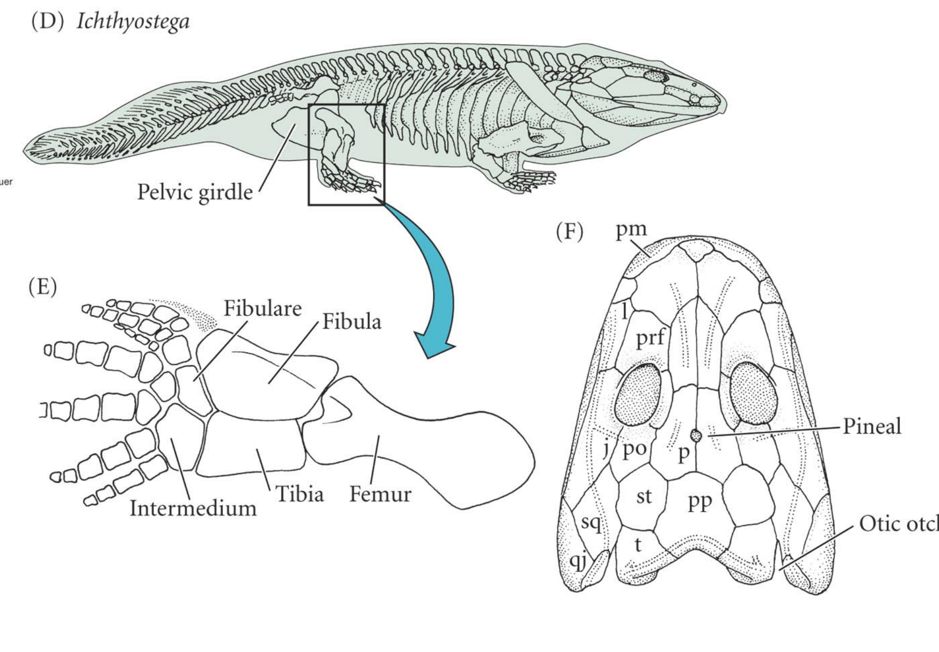


Origin of Tetrapods

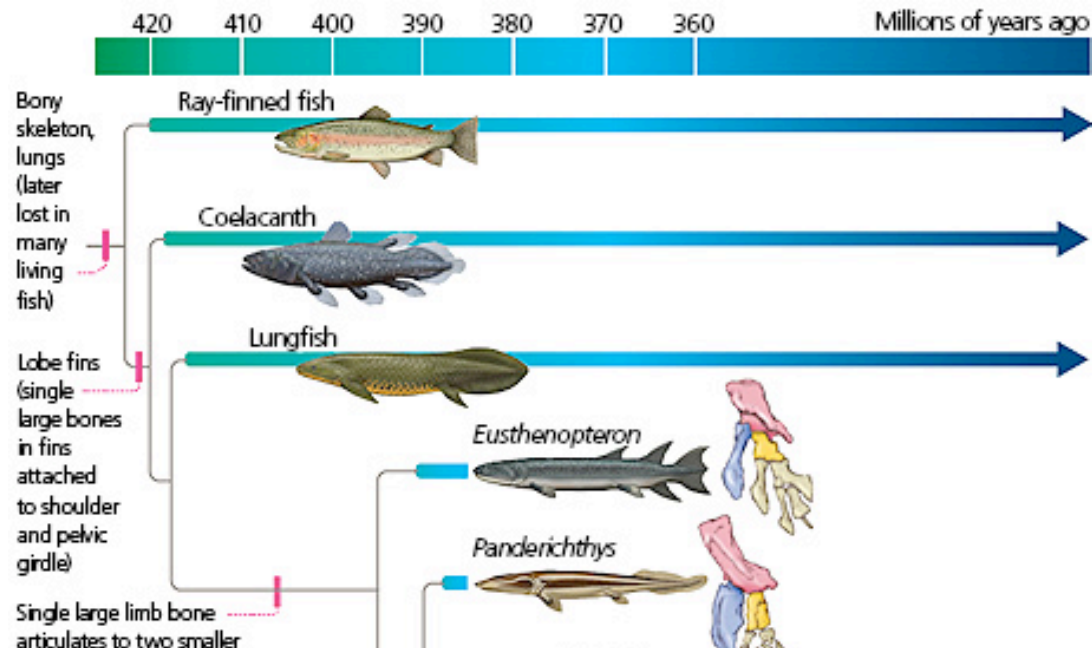


A rhipsidian - ancestor to tetrapods – 390 mya

Early amphibian 370 mya



Tetrapods (‘four feet)



Lobe-finned fishes

(Sarcopterygii)

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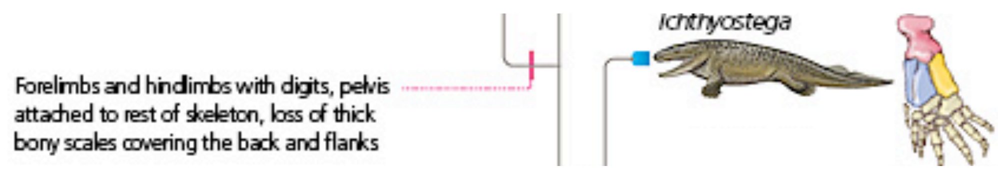
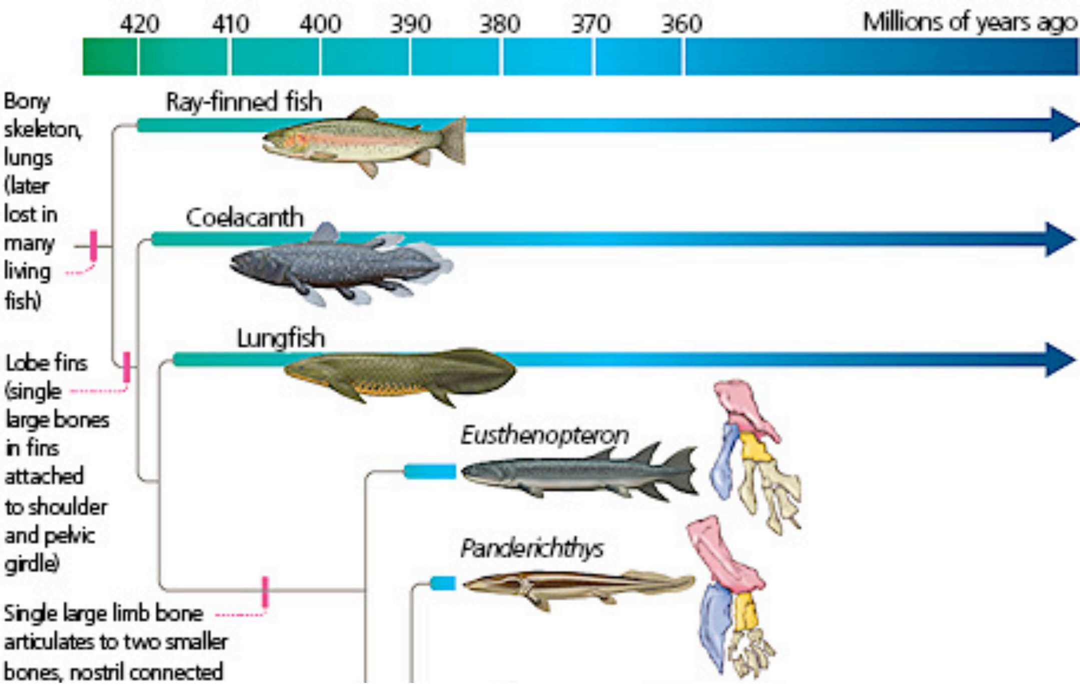


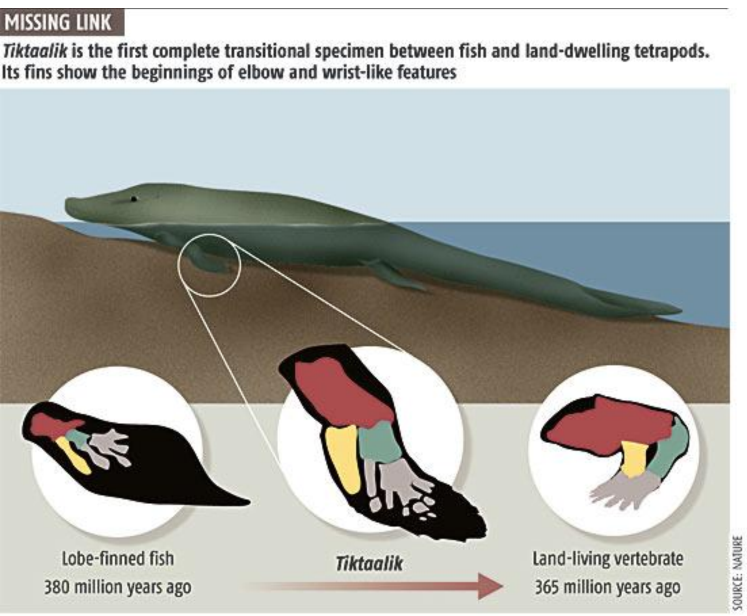
Icthyostega (late Dev.) had similar tail and teeth but no gill cover bones and flexible neck and flexible wrists

Tetrapods ('four feet)

Discovery of "*Tiktaalik*"

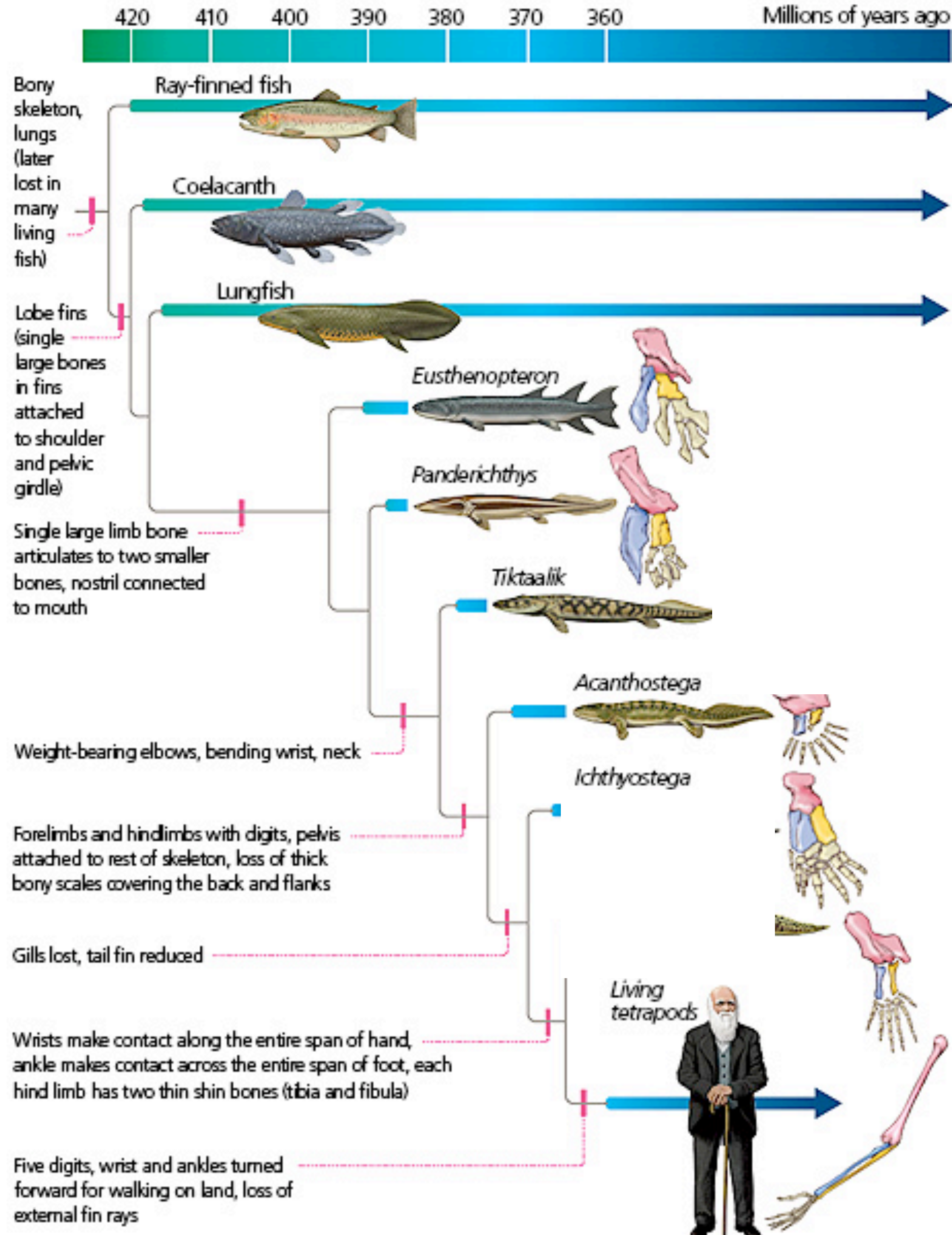
Flexible head and wrists





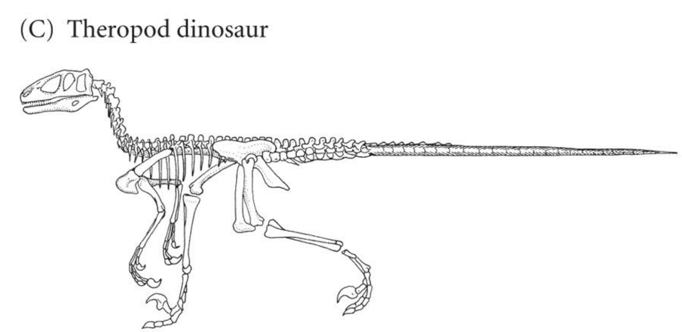
Tetrapods ('four feet)

Tiktaalik" was the missing link between marine animals and terrestrial tetrapods



Origin of Birds - Archaeopteryx

150 mya

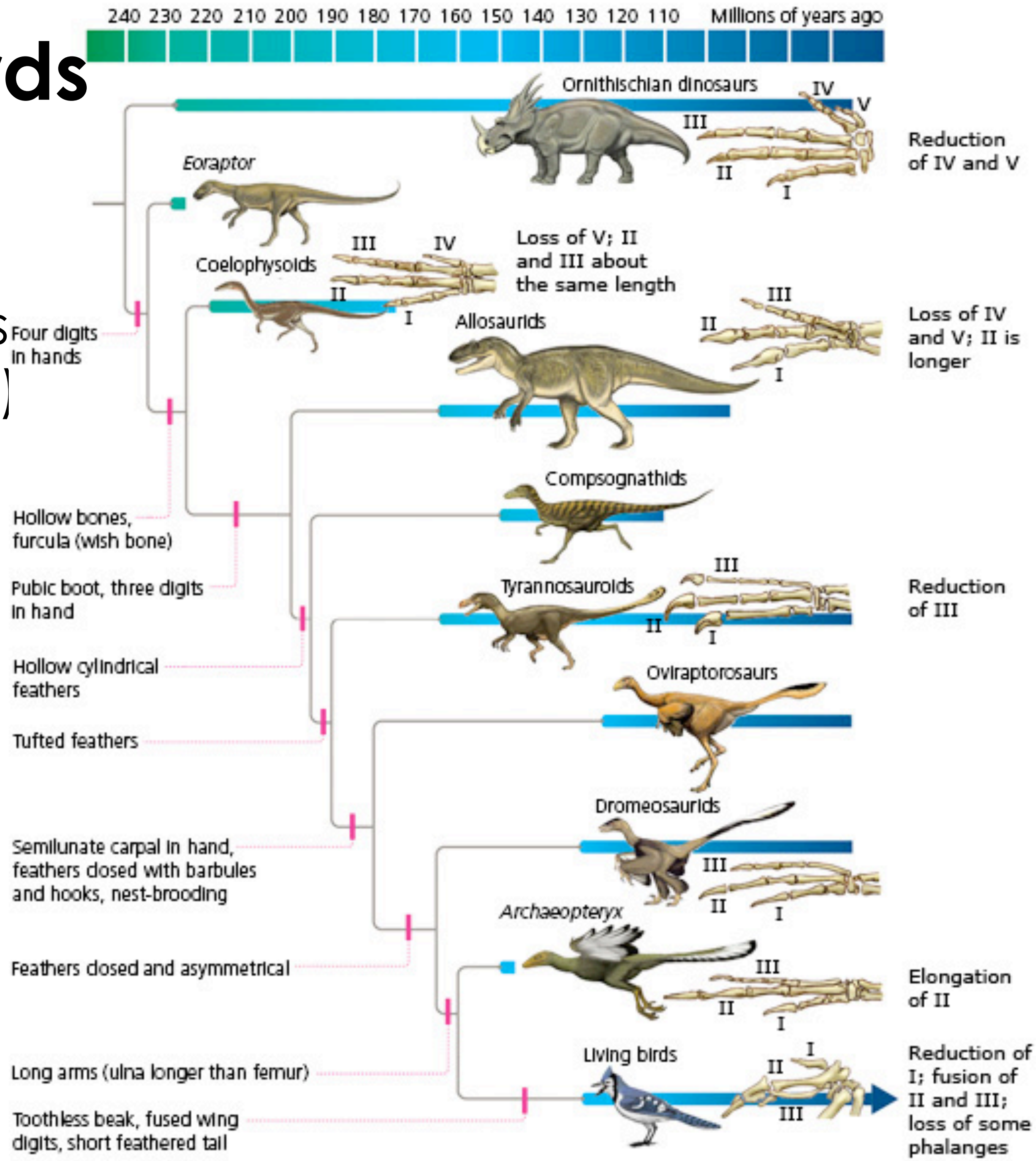


EVOLUTION, **Figure 4.8** © 2005 Sinauer Associates, Inc.

Origin of birds

Archaeopteryx link between carnivorous dinosaurs (theropods)

-hollow bones



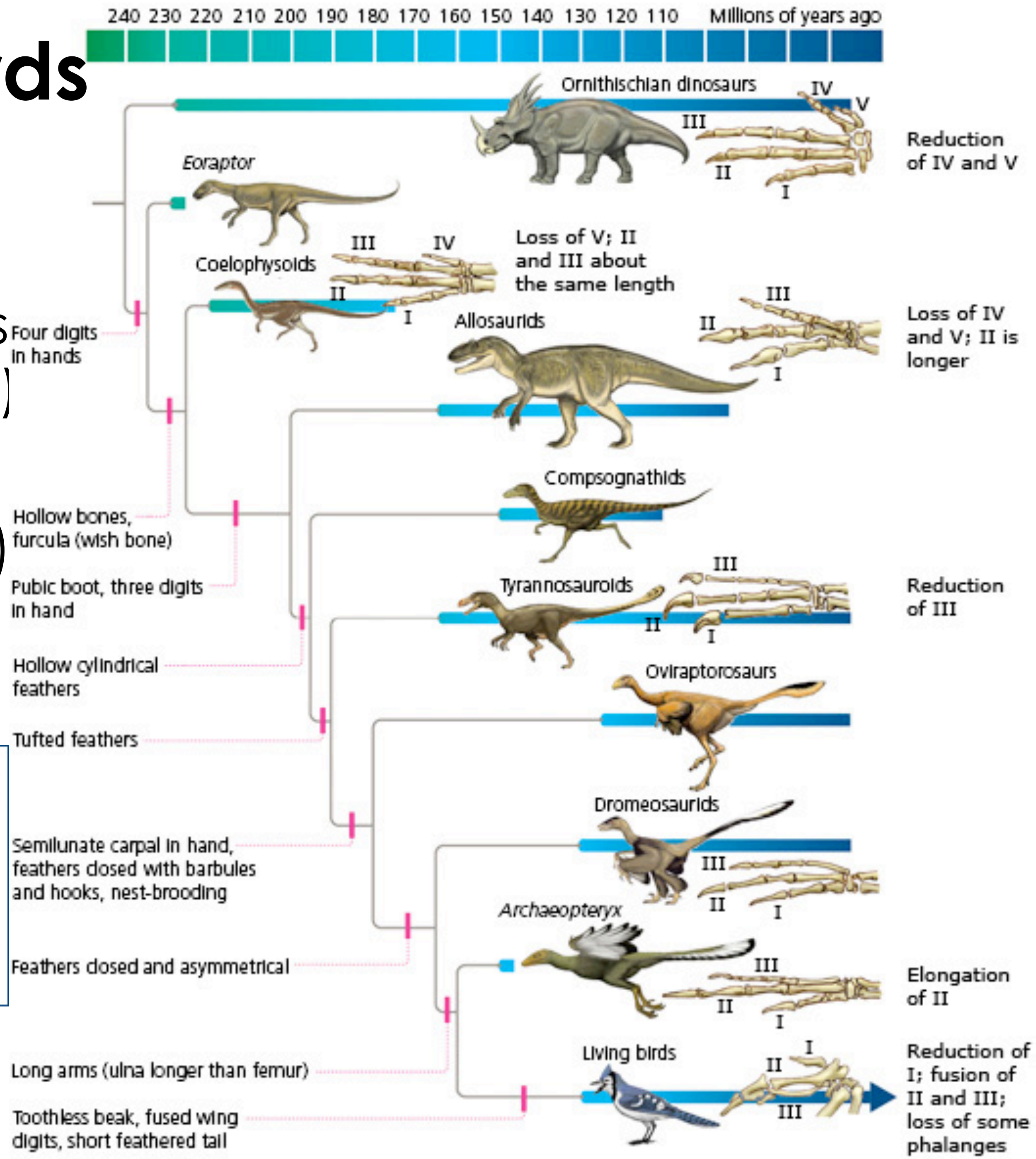
Origin of birds

Archaeopteryx link between carnivorous dinosaurs (theropods)

-hollow bones

-1st feathers (*Comps.*)

-types of feathers (oviraptosaurs)



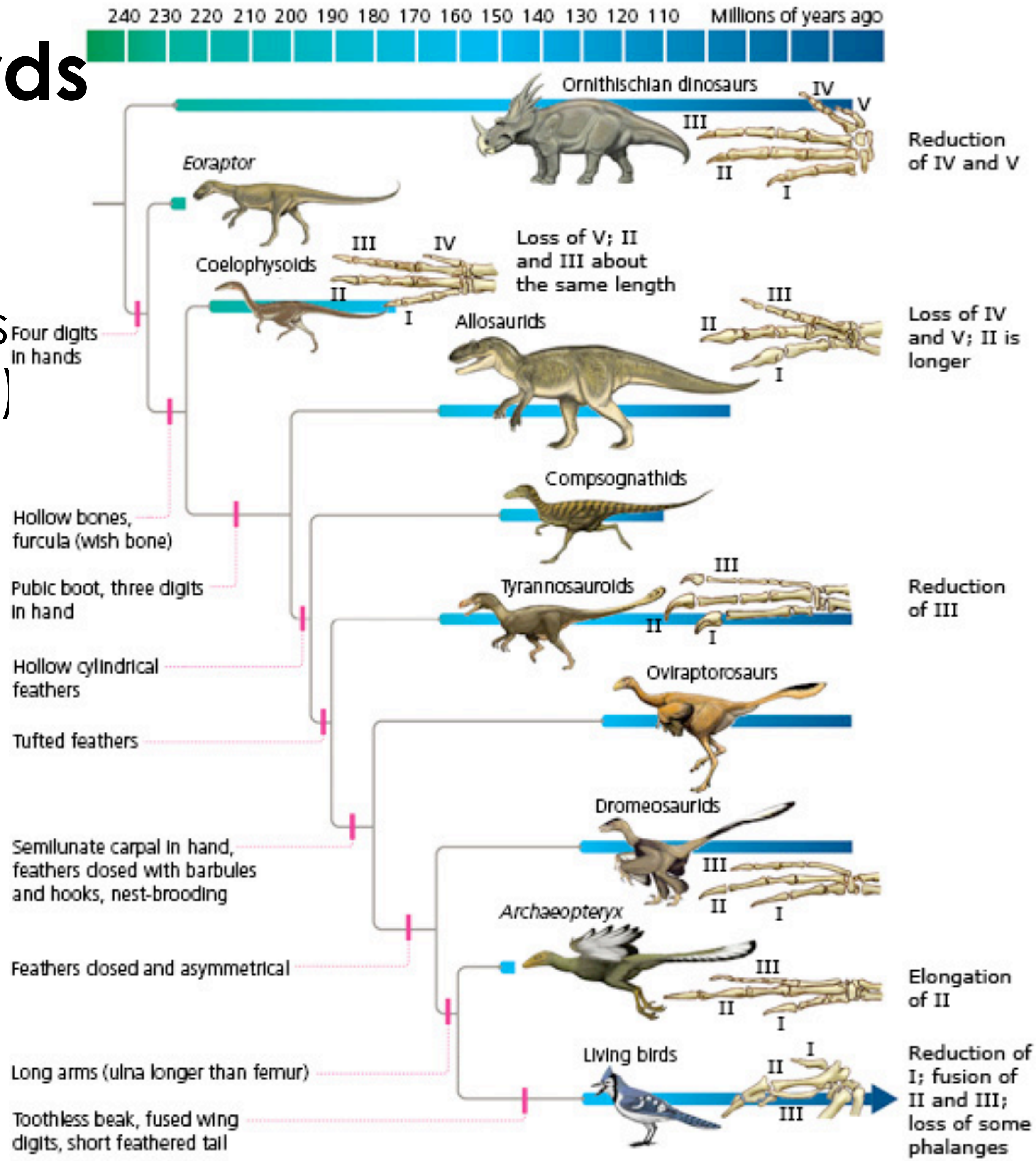
Origin of birds

Archaeopteryx link between carnivorous dinosaurs (theropods)

-loss of 4 & 5th digits

-fusing of wrist bones under 1st & 2nd digits

--modified form in birds allows thrust in flying



L28-Evolution in Geological Time+Micro/Macroevolution

Microevolution and Macroevolution

Microevolution occurs **within** a species

-variations in allele frequencies (population genetics)

examples: antibiotic resistance, mosquito resistance to DDT, pepper moths and industrial melanism

Macroevolution occurs **across** species

-modifications often resulting in the emergence of new species

examples: appearance of feathers in therapods, modification of fins into hindlimbs, horse evolution

The same evolutionary processes are work, but the scales (e.g. time and/or spatial) to which their impacts are observed do vary.

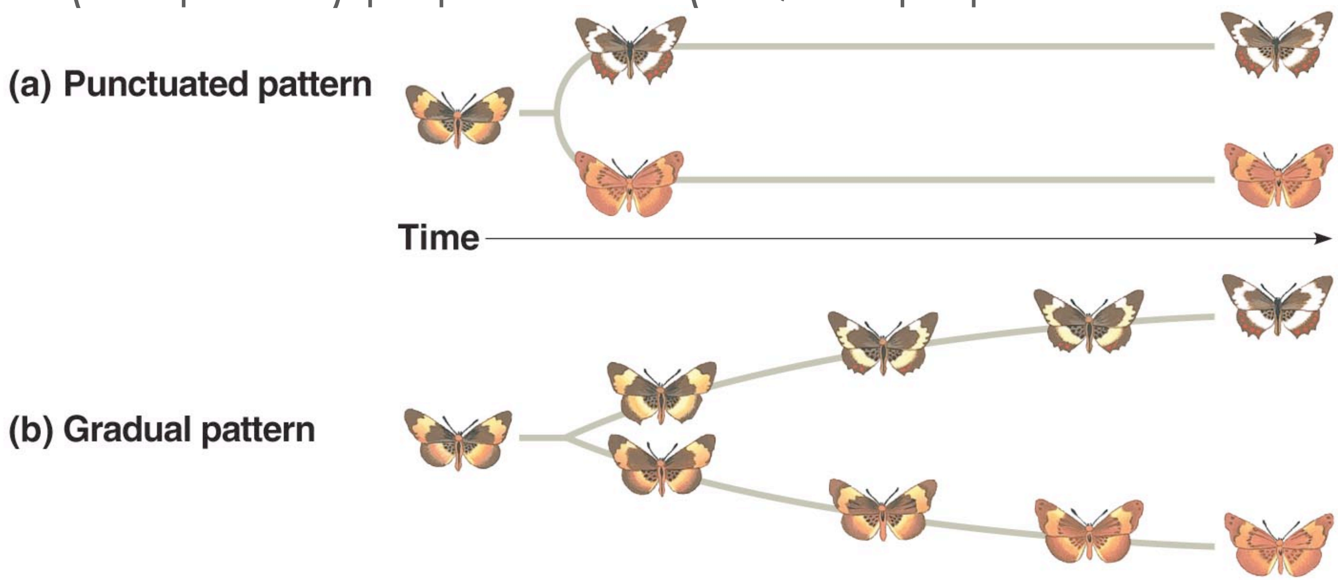
Macroevolution

Draws on the fossil record, phylogenetic patterns of change, evolutionary developmental biology, geography, genetics and ecology

The same evolutionary processes are work, but the scales (e.g. time and/or spatial) to which their impacts are observed do vary.

Punctuated Equilibrium

- Pattern of change in the fossil record
  - Long periods of little or no change (stasis) followed by rapid change
  - Stasis is punctuated by rapid change
- A hypothesis about the evolutionary process
  - Evolutionary change accompanied speciation which occurred "off stage" in small (allopatric) populations (i.e., subpopulations of a species).



But why is evolution so slow (‘stasis’)?

Rapid evolution can be explained by mutations, genetic variation, short-term evolutionary rates and divergence of closely related taxa

Three hypotheses

•Genetic or developmental constraints

•Stabilizing selection

•Evolutionary changes in local populations don’t contribute to long-term changes