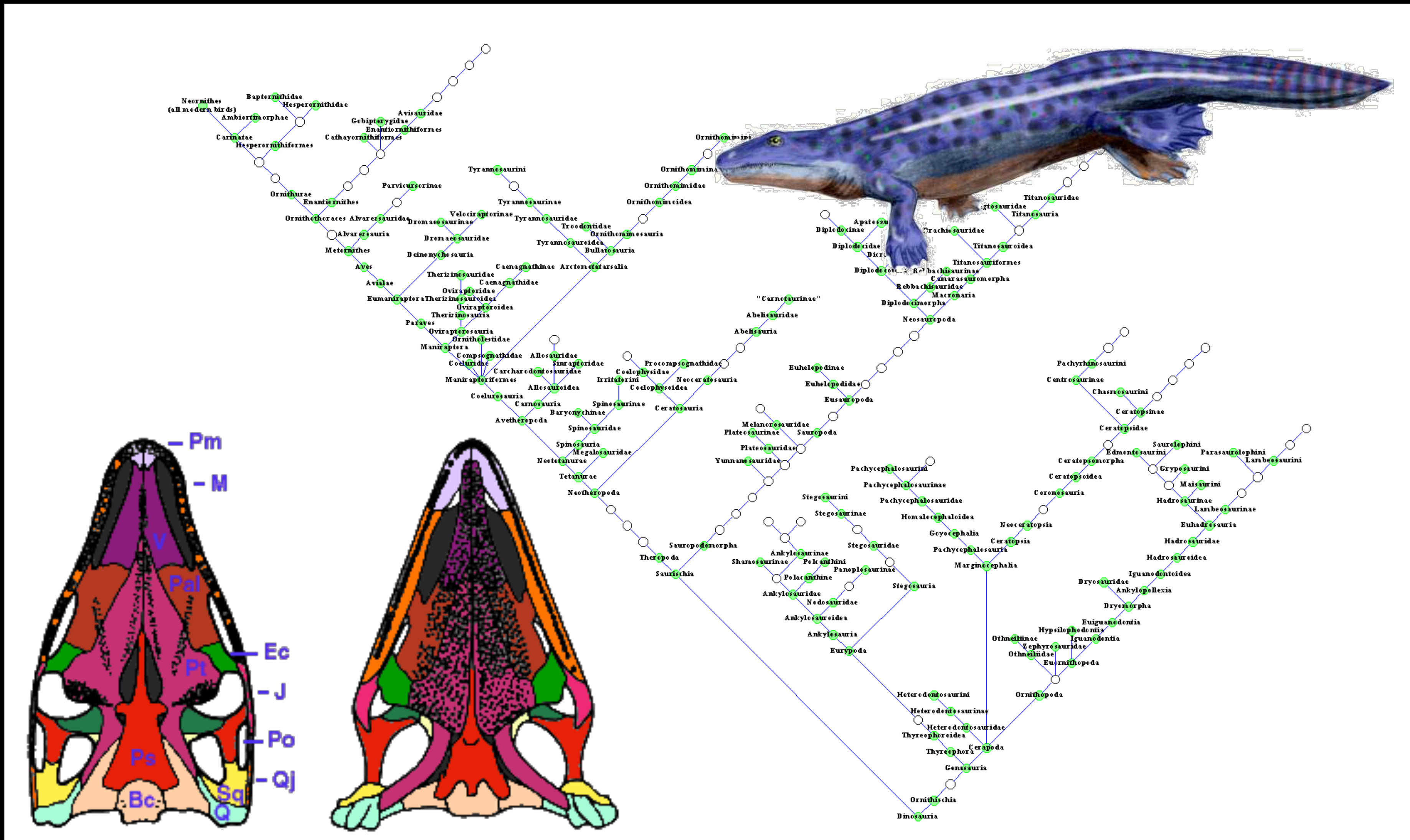
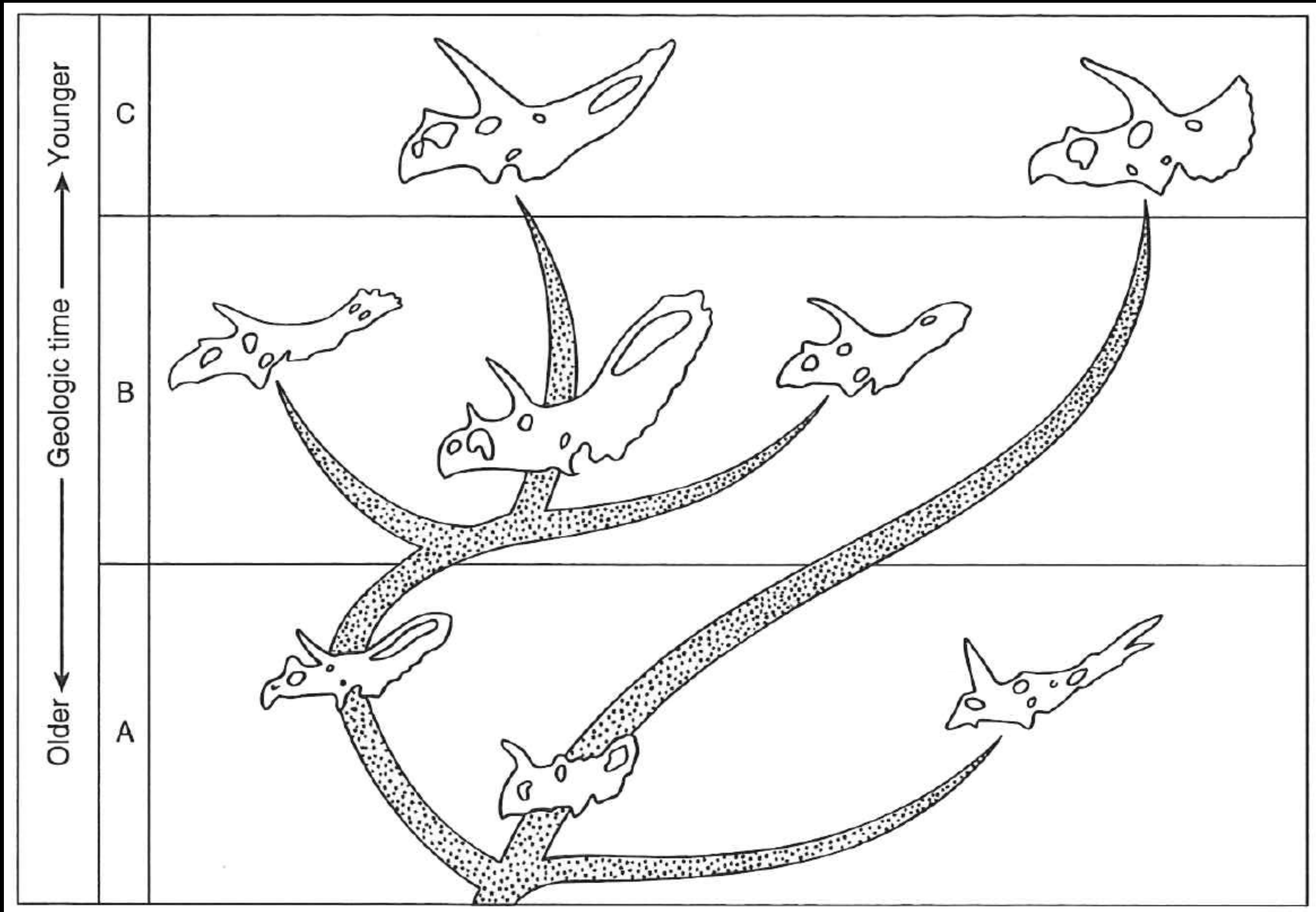
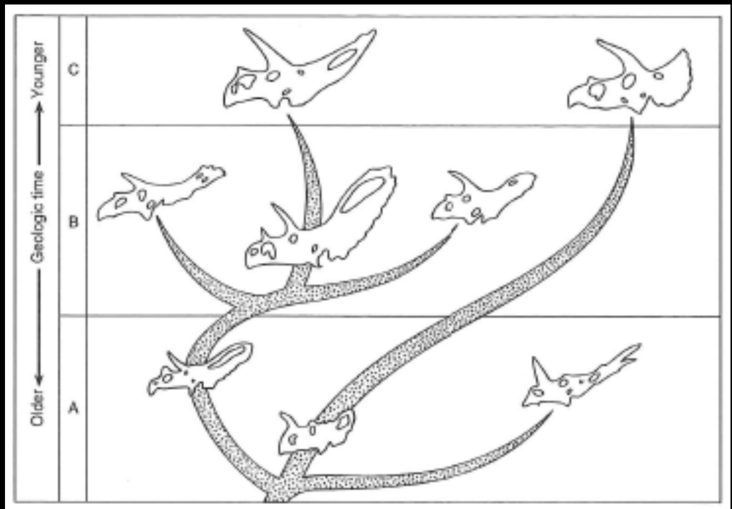
Phylogeny & the Origin of Dinosaurs



Stratophenic phylogeny



Stratophenic phylogeny



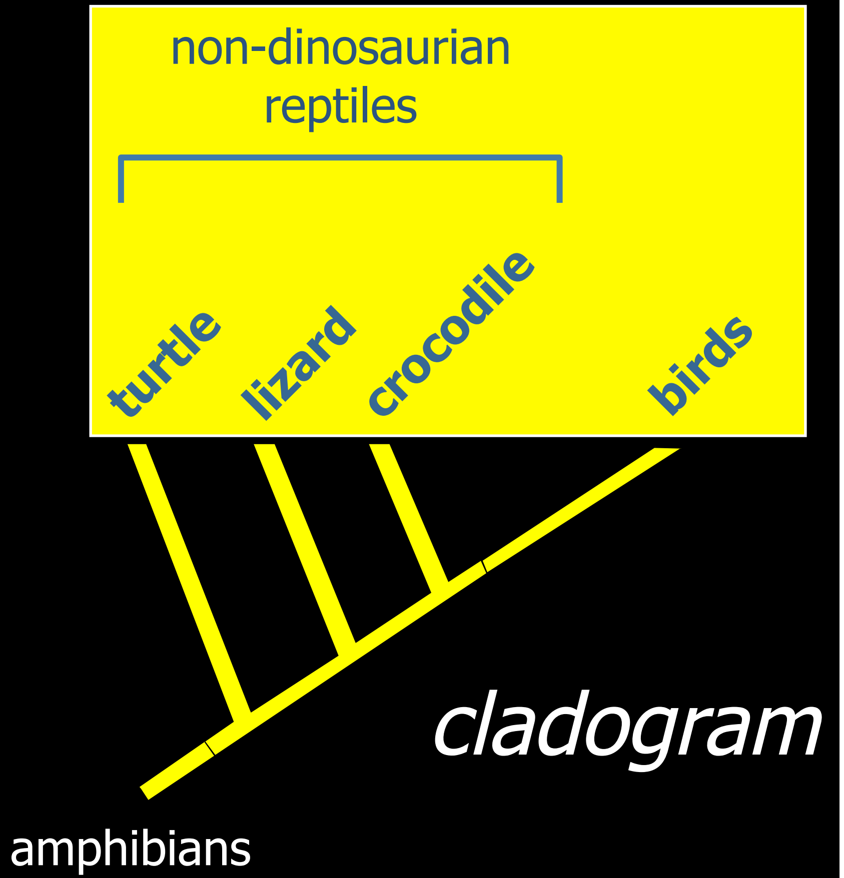
Problems:
fossil record is not complete!

→ important species might not be preserved at all

→ fossil record (the stratigraphic range) of certain species might be incompletely know

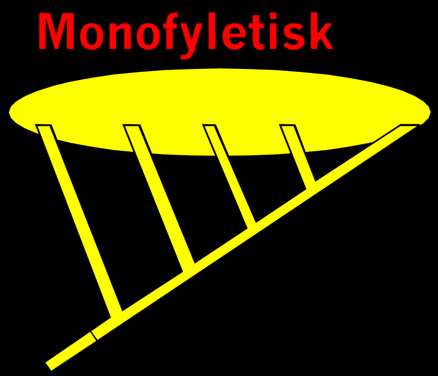
Cladistic phylogeny

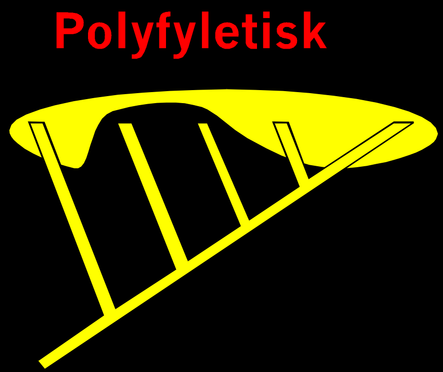
- Makes fewer assumptions about the completness of the fossil record
- A method to analyze the relationship of organisms by comparing their character traits with a distantly related group



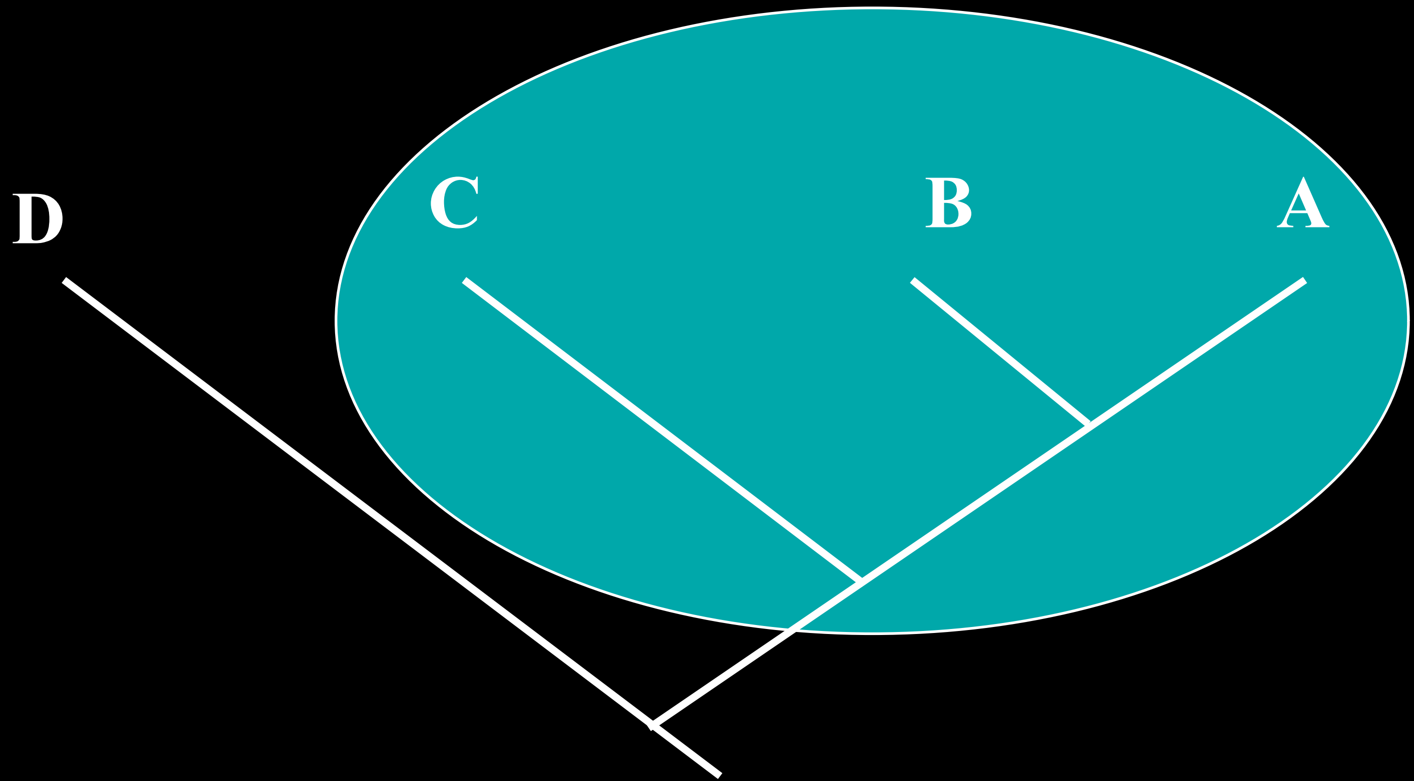
Cladistics

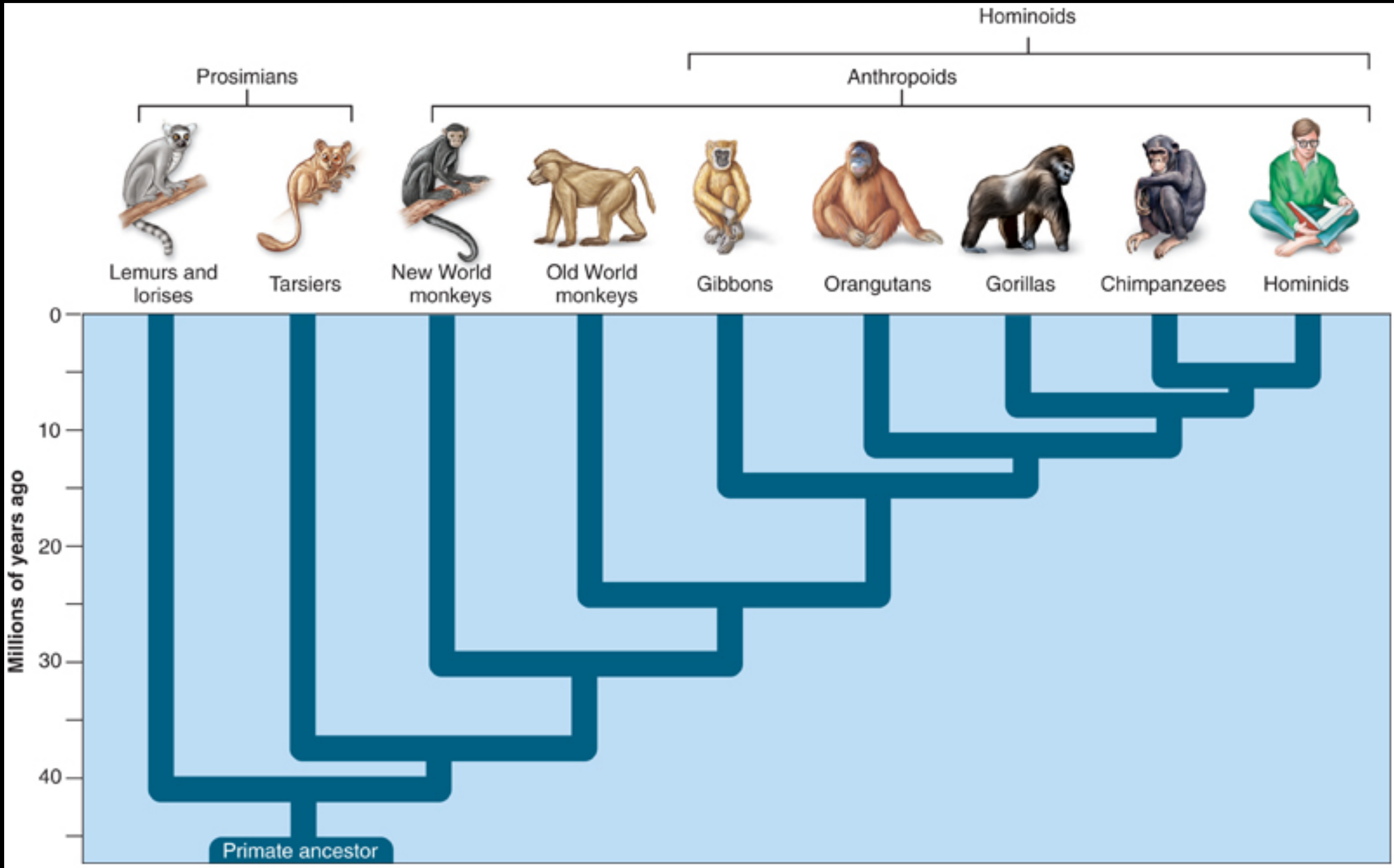
- homologue characters (common origin)– lead to monophyletic groups
- analogue characters (convergence) – lead to polyphyletic groups



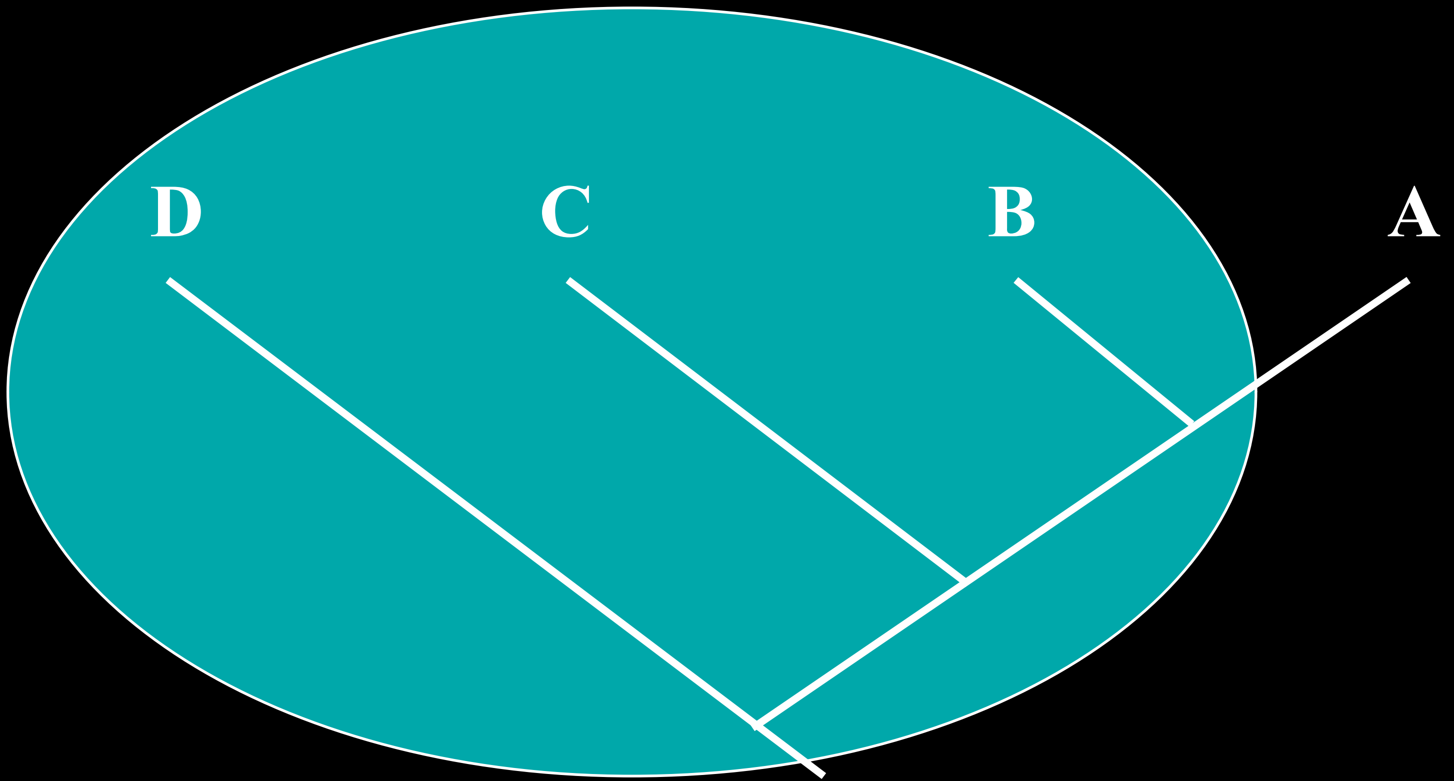


- **Monophyletic** (“a branch”): all groups with a common ancestor

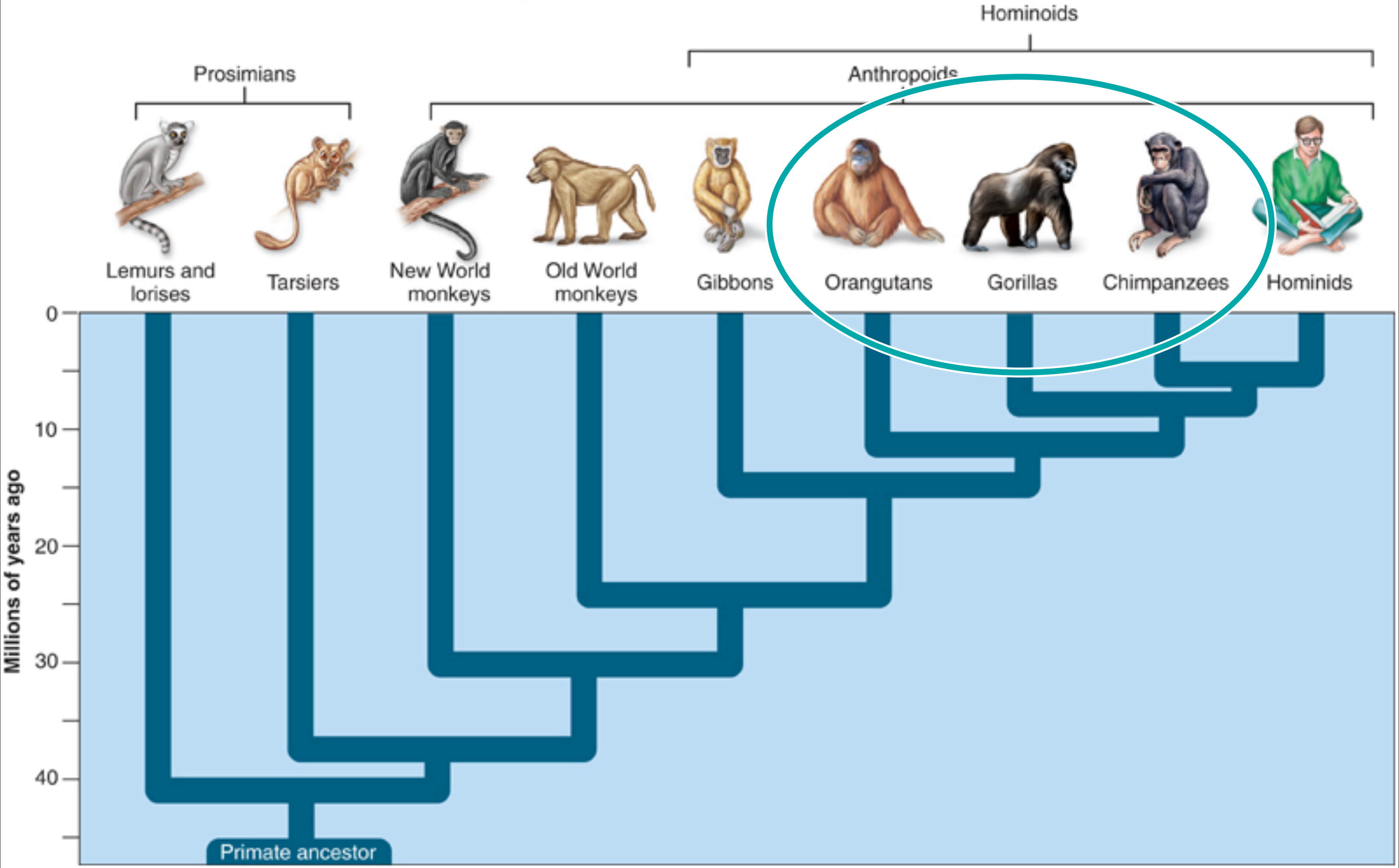



Hominoids
Anthropoids
Prosimians
Lemurs and lorises
Tarsiers
New World monkeys
Old World monkeys
Gibbons
Orangutans
Gorillas
Chimpanzees
Hominids
Millions of years ago
0
10
20
30
40
Primate ancestor

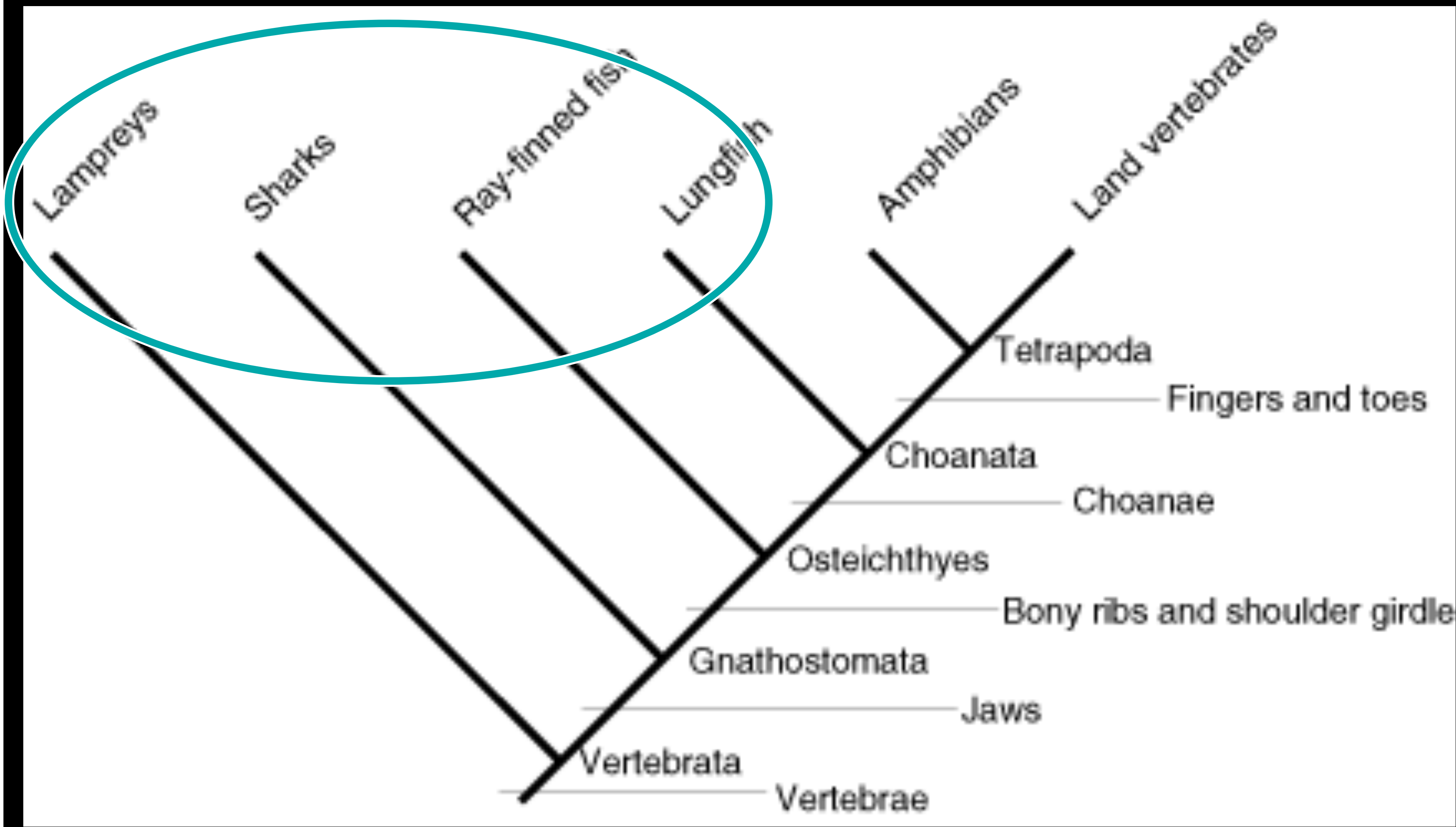
- **Paraphyletic** ("almost a branch"): Certain, but not all groups descending from a common ancestor



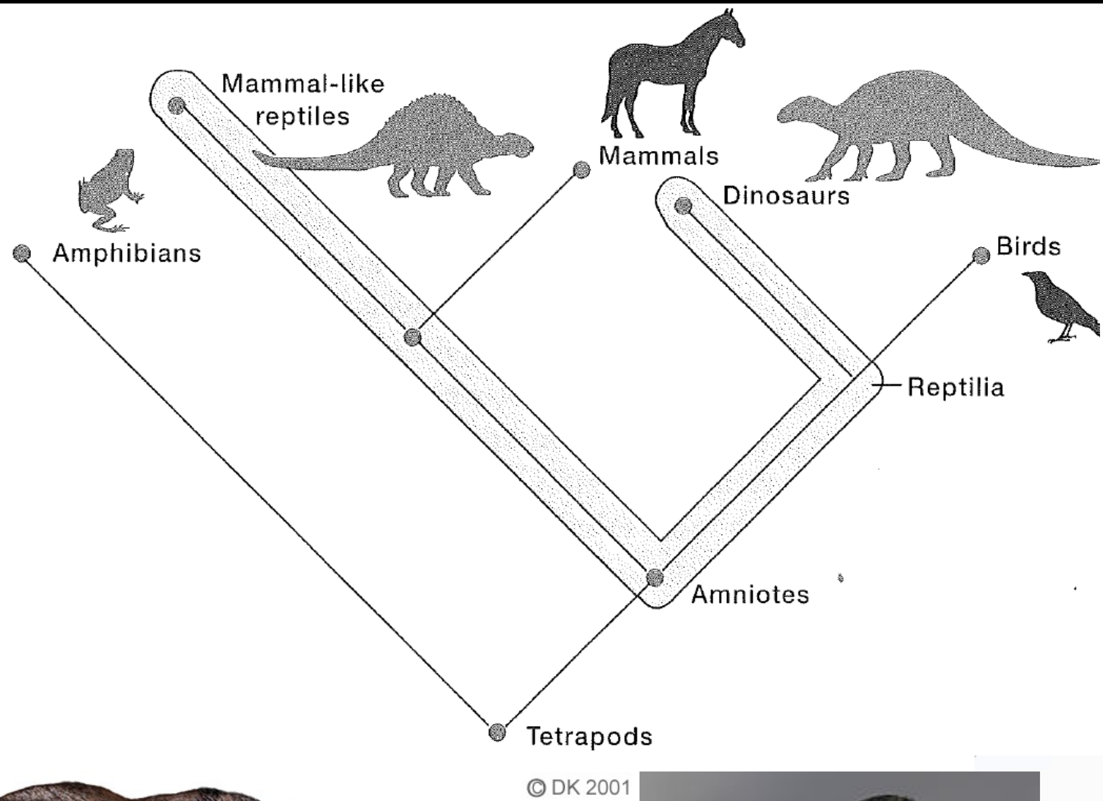
Monkeys or apes would be a paraphyletic group

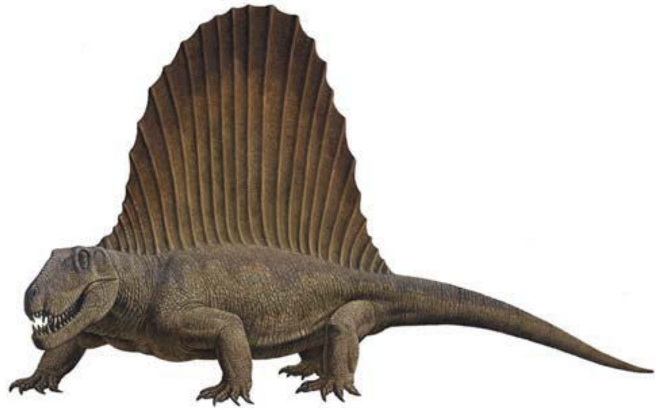


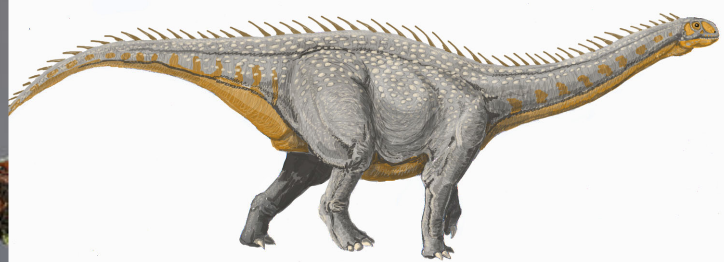
"Fish" would be a paraphyletic group



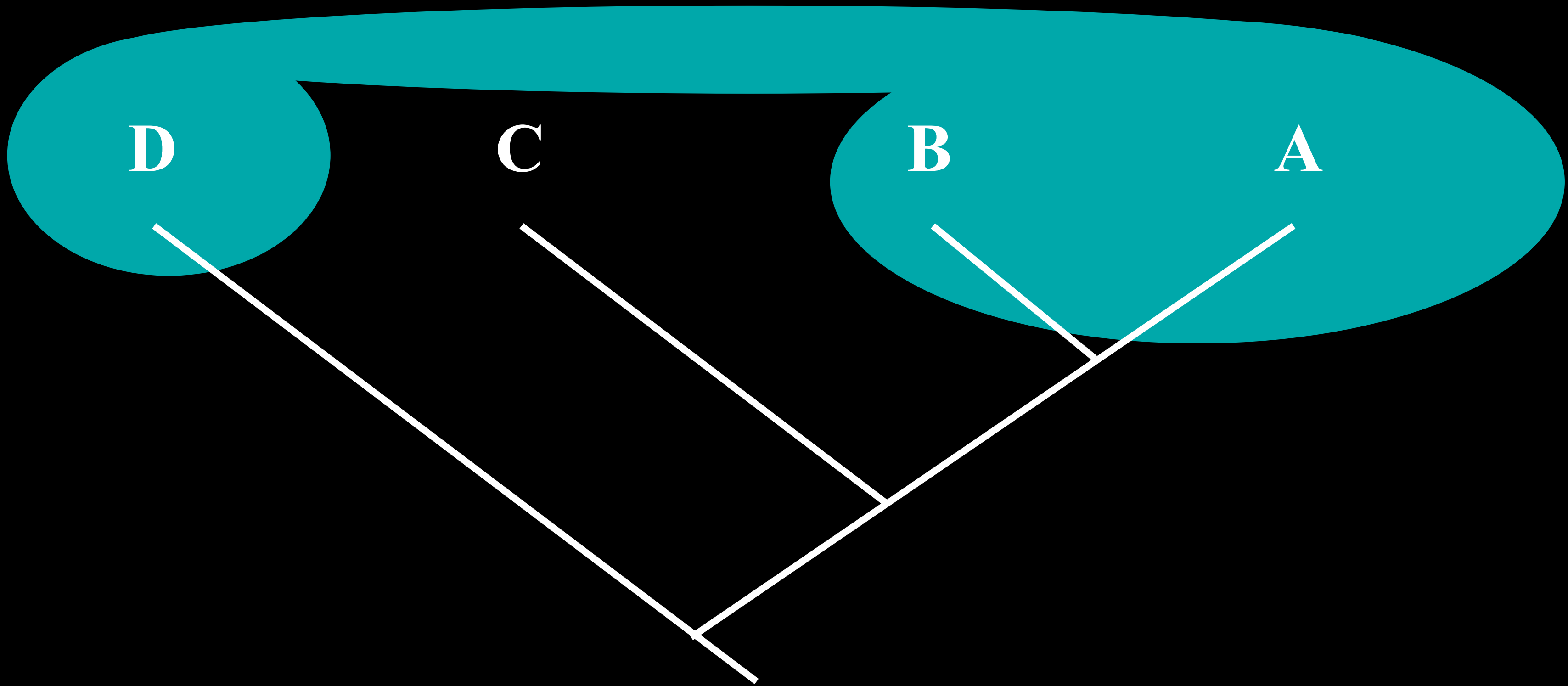
Reptiles would be a paraphyletic group



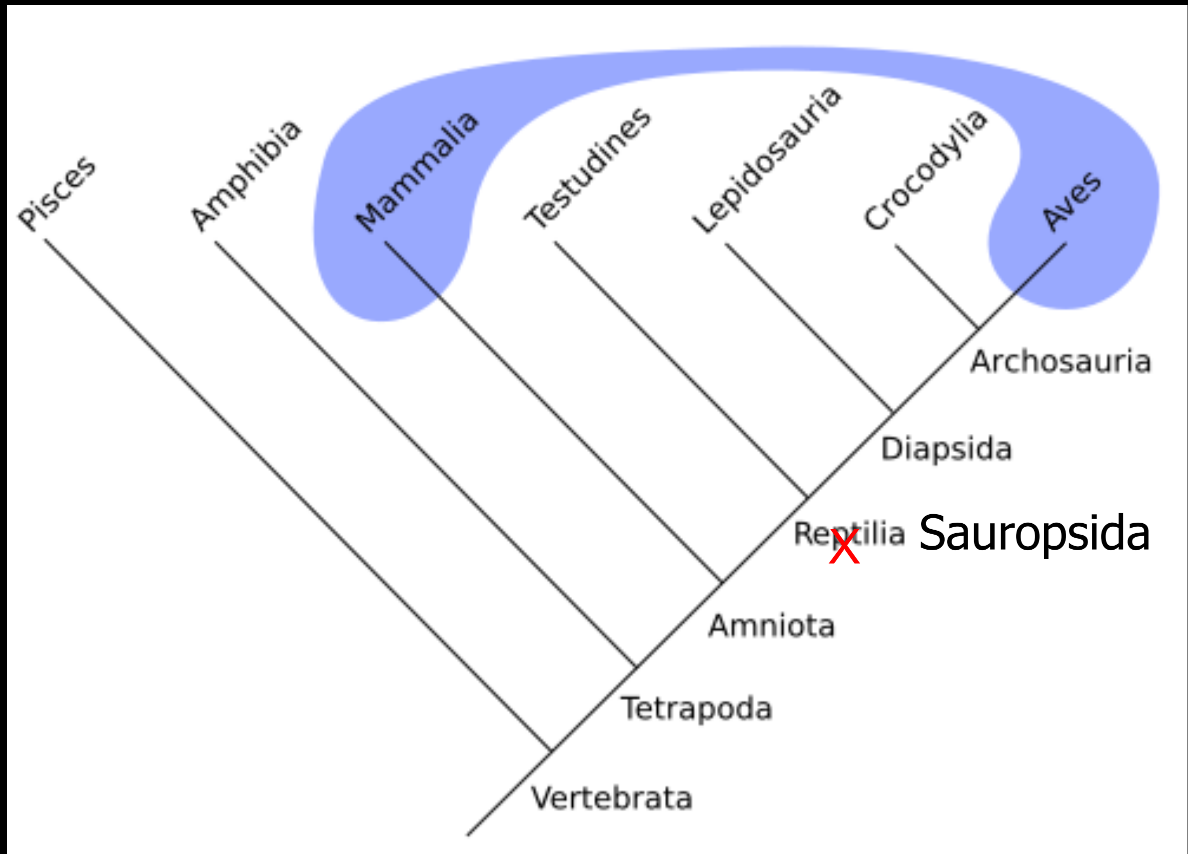




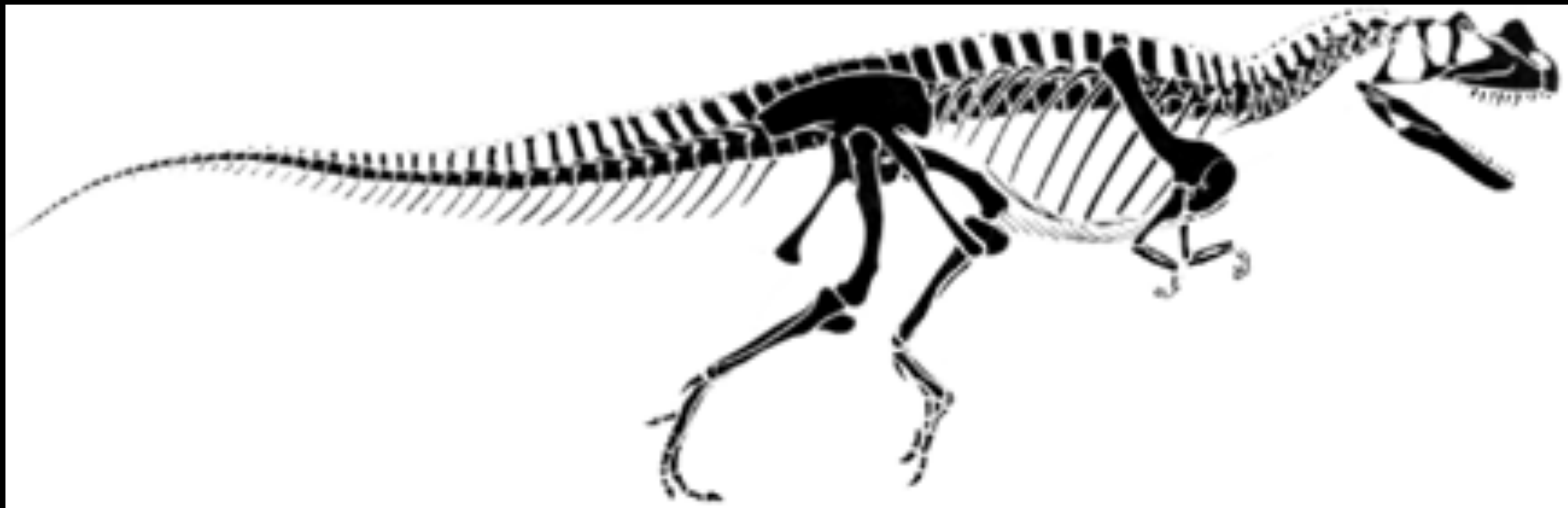
- **Polyphyletic** (“several branches"): groups not sharing a close common ancestor



Warm-blooded animals = polyphyletic

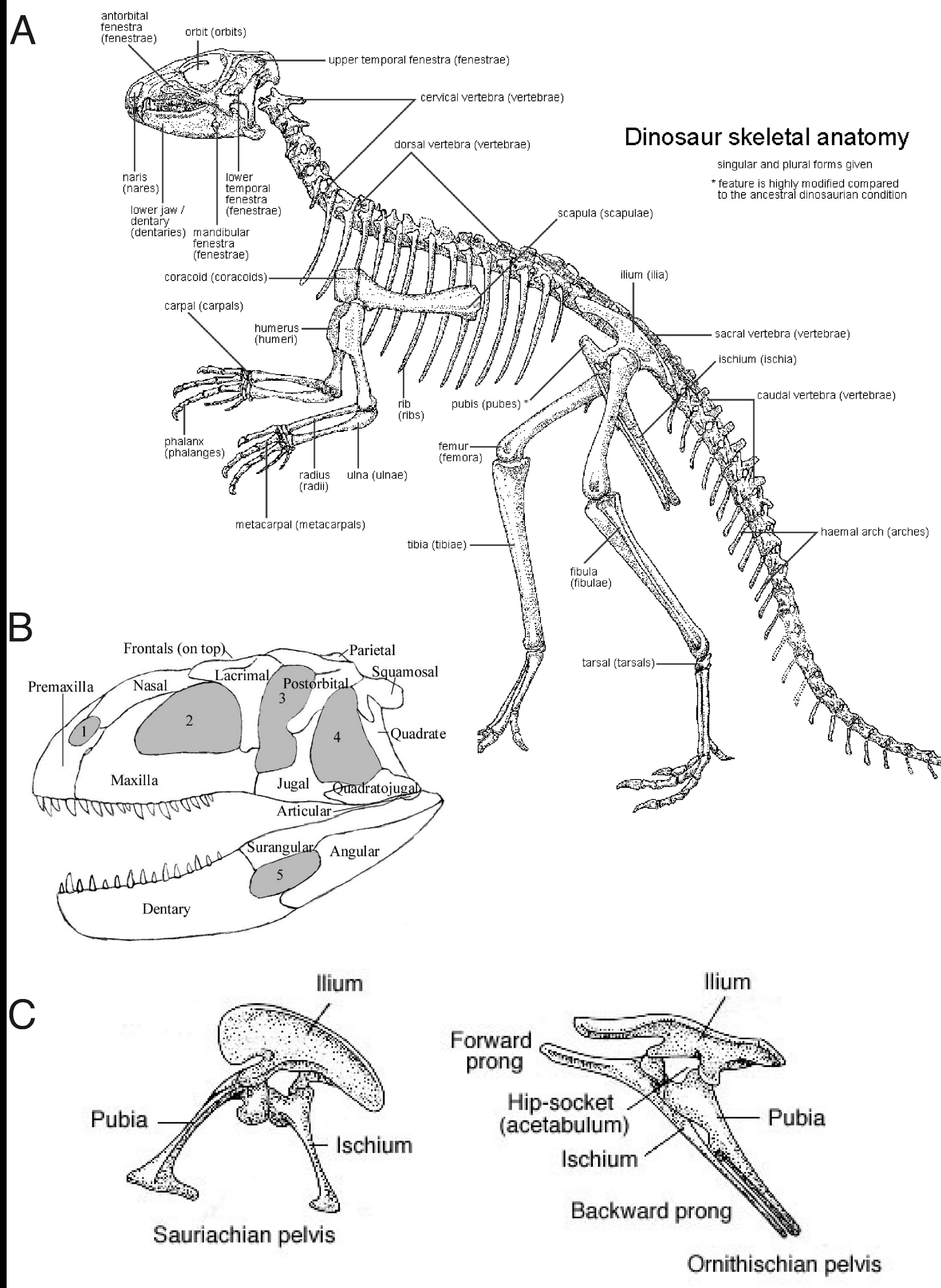


Dinosaur anatomy



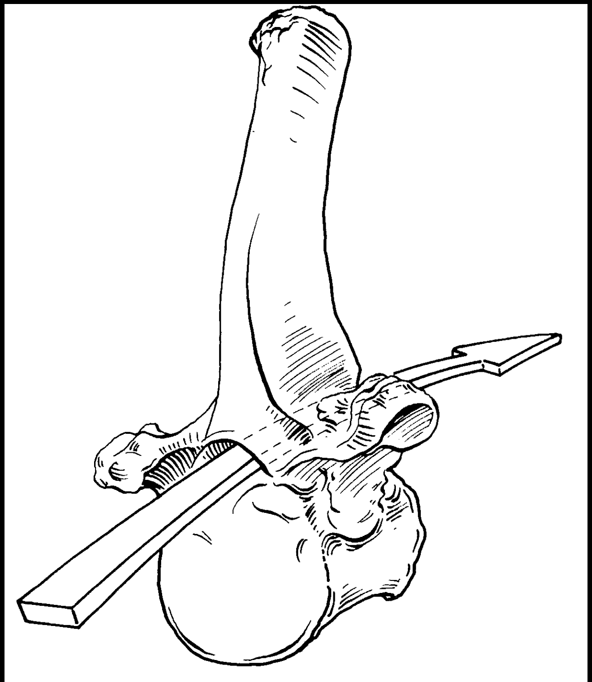
[handout]

Dinosaur anatomy



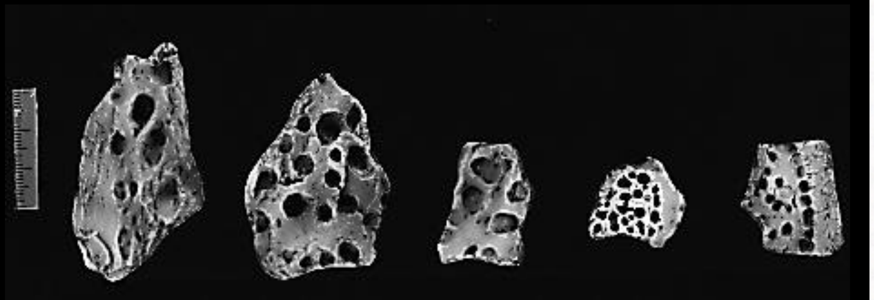
Vertebrates

- segmented internal skeleton (endoskeleton) with a dorsal backbone
- skeleton consists of bones (calcium phosphate) & cartilage (*brosk*)
- head (cranium) bears brain - Craniata

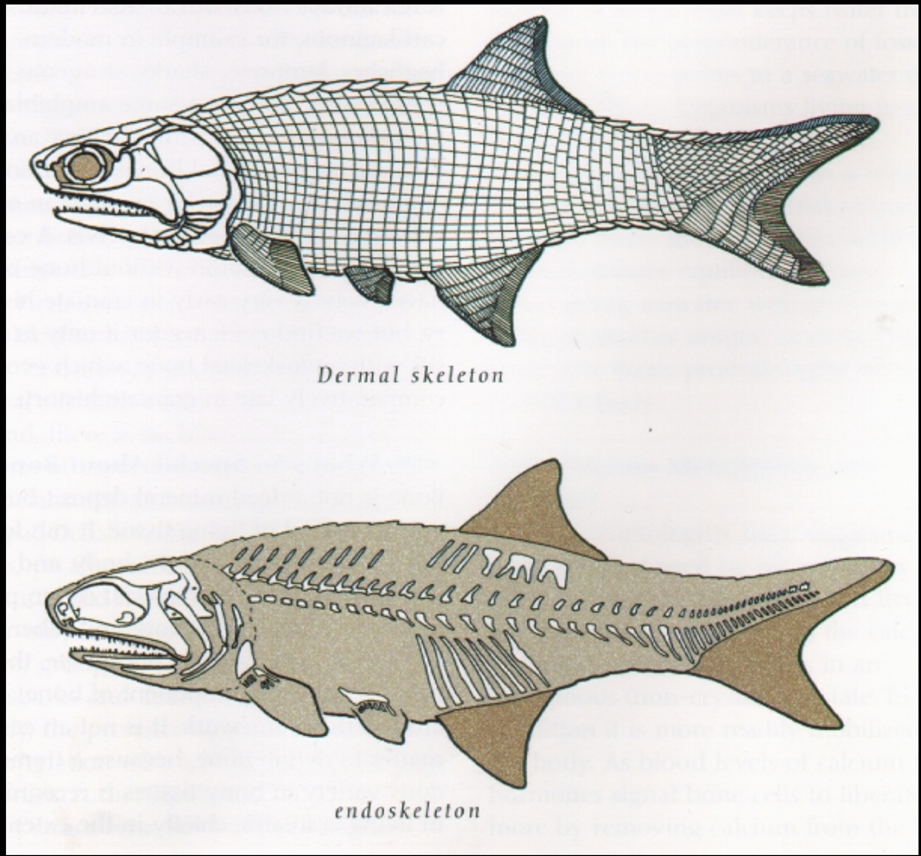


Skeleton
(connective tissue-cartilage-bone)

- Exoskeleton – is dermally derived: scales (keratin) and osteoderms (scutes)



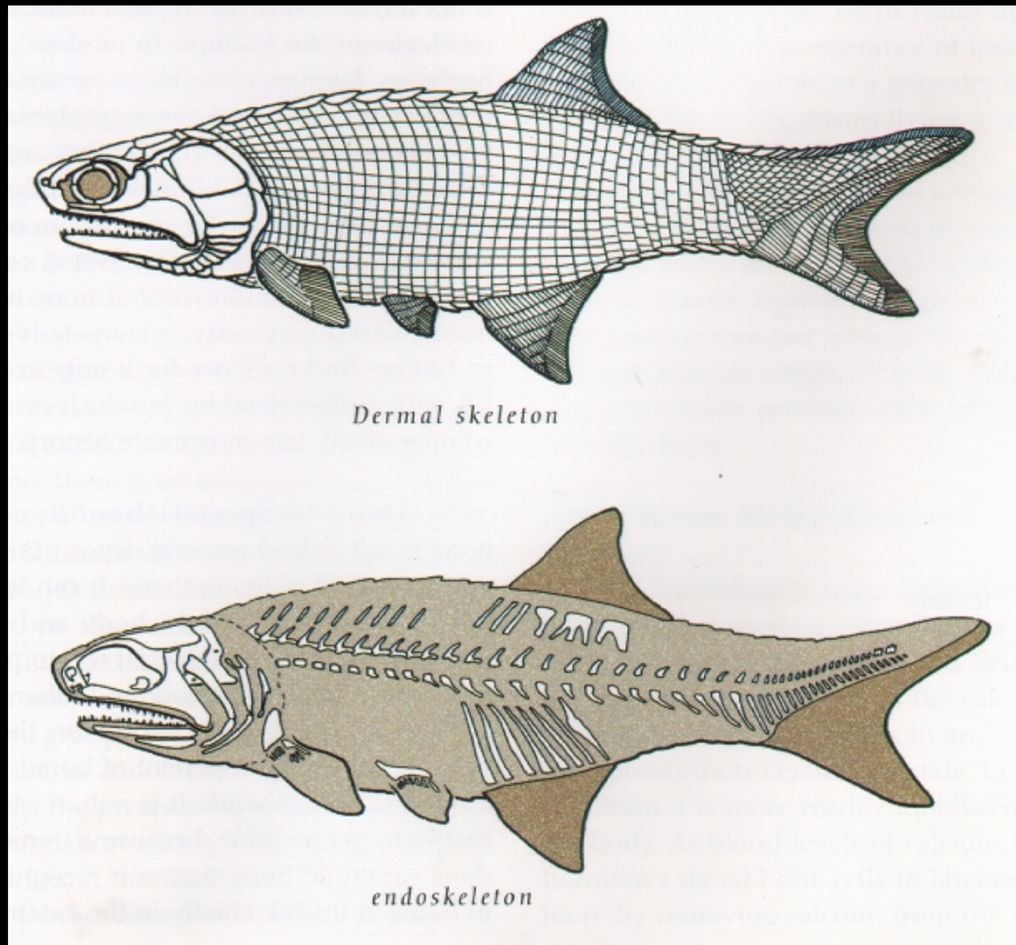
Osteoderms of a crocodile

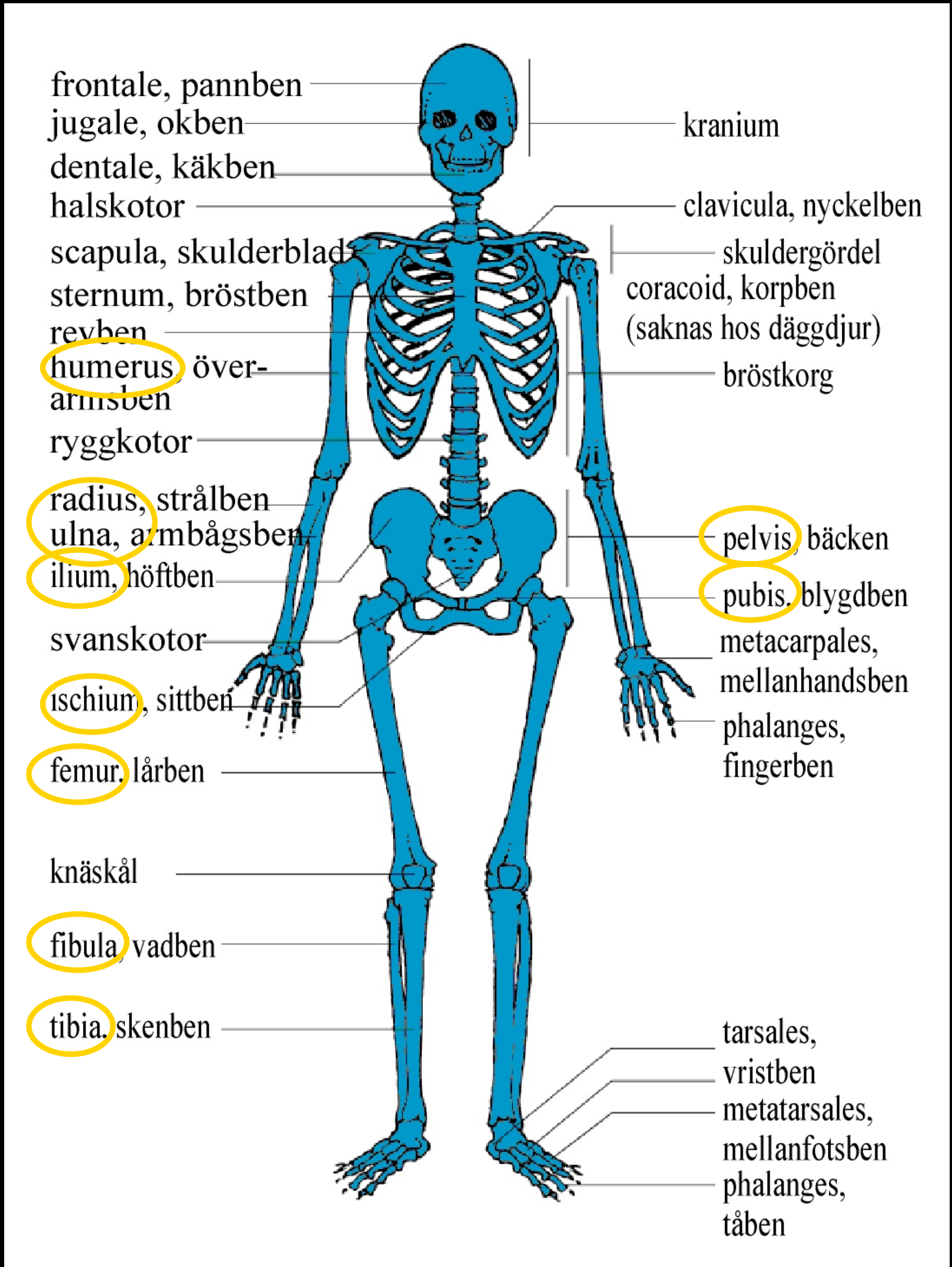


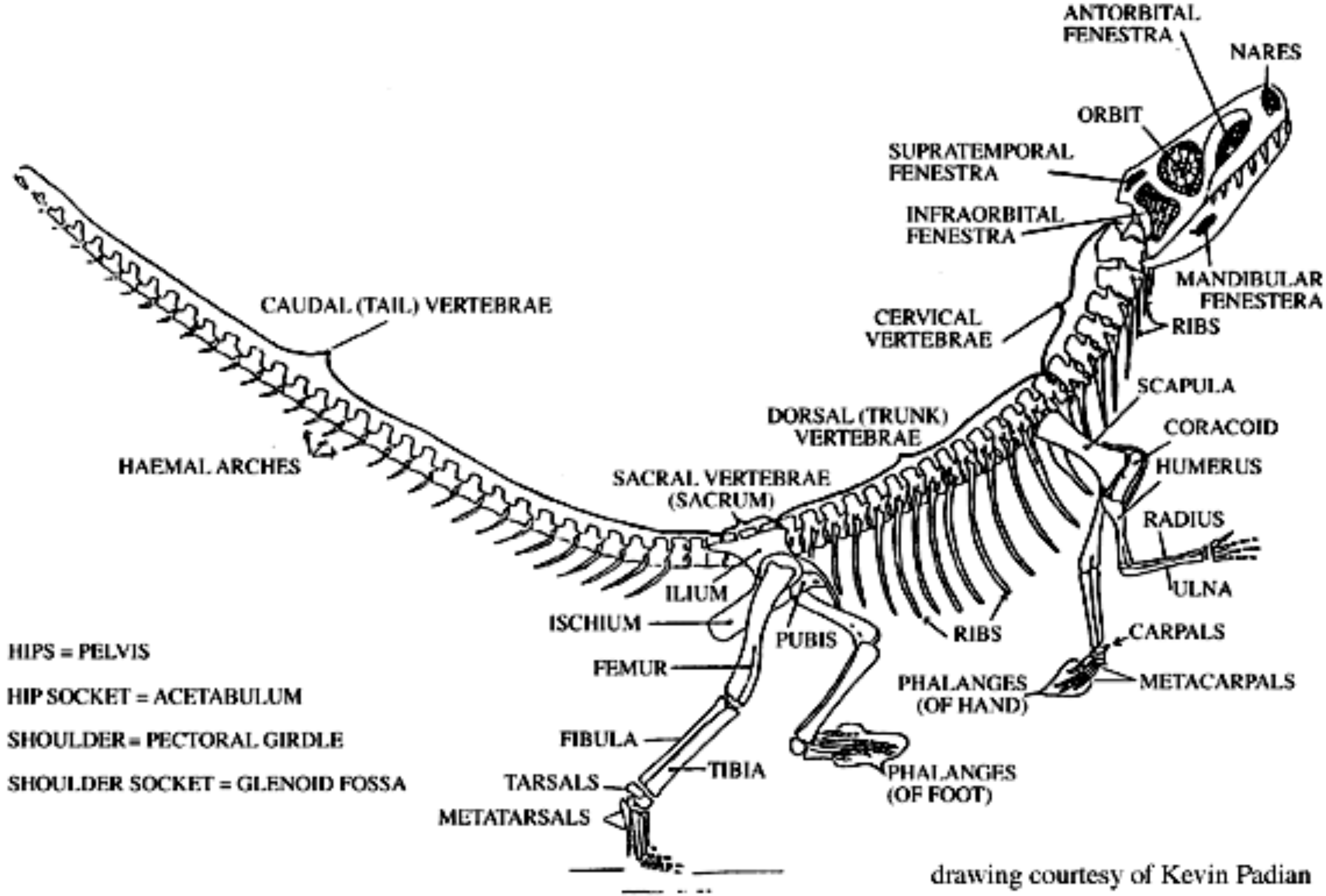
Skeleton
(connective tissue-cartilage-bone)

- Parts of the endoskeleton (e.g., rib cage) are made of cartilage
- Why calcium phosphate?

teeth of a crocodile

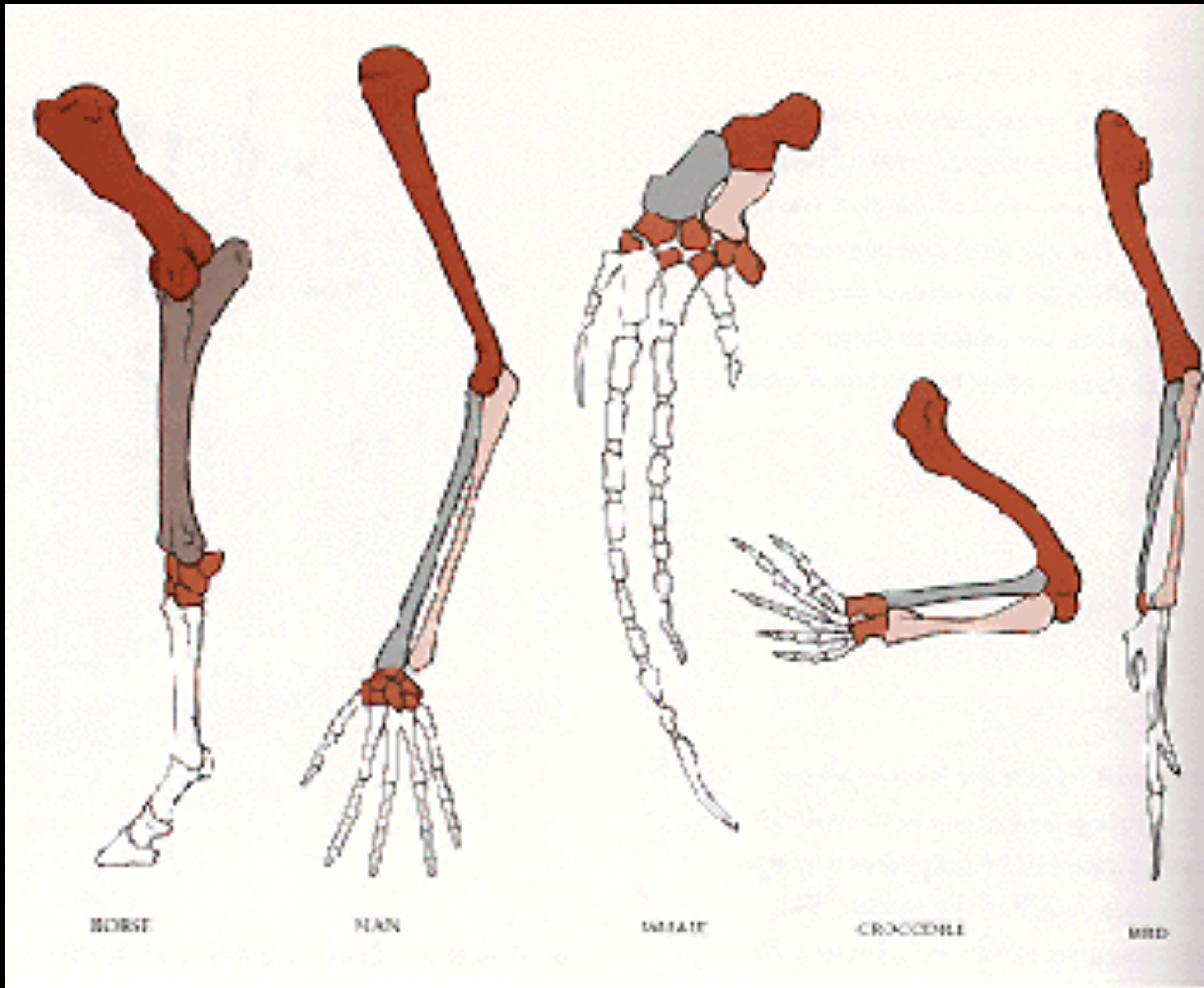


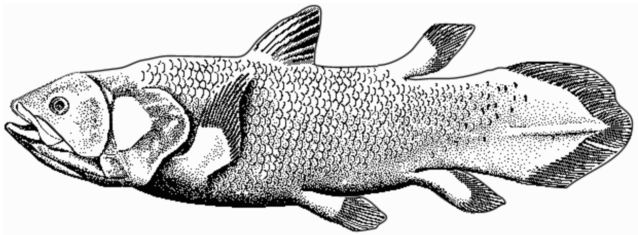

frontale, pannben
jugale, okben
dentale, käkben
halskotor
scapula, skulderblad
sternum, bröstben
revben
humerus, över-
armsben
ryggkotor
radius, strålben
ulna, armbågsben
ilium, höftben
svanskotor
ischium, sittben
femur, lårben
knäskål
fibula, vadben
tibia, skenben
kranium
clavicula, nyckelben
skuldergördel
coracoid, korpben
(saknas hos däggdjur)
bröstkorg
pelvis, bäcken
pubis, blygdben
metacarpales,
mellanhandsben
phalanges,
fingerben
tarsales,
vristben
metatarsales,
mellanfotsben
phalanges,
tåben

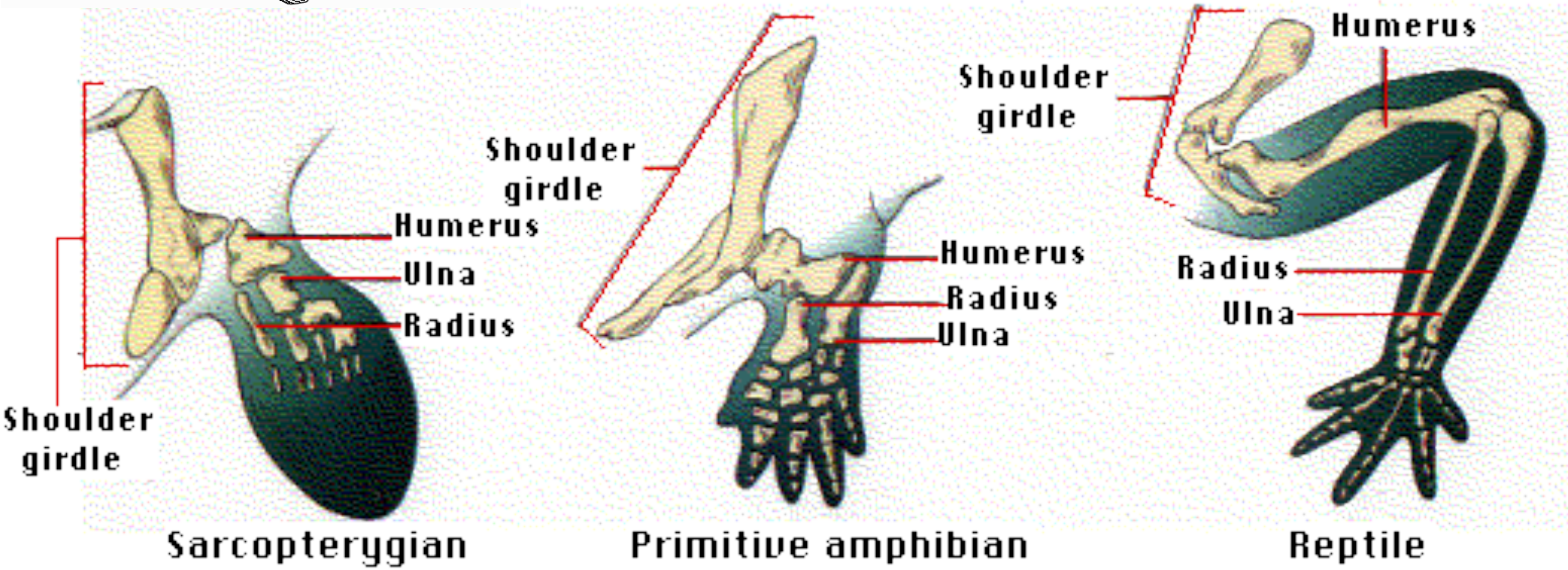


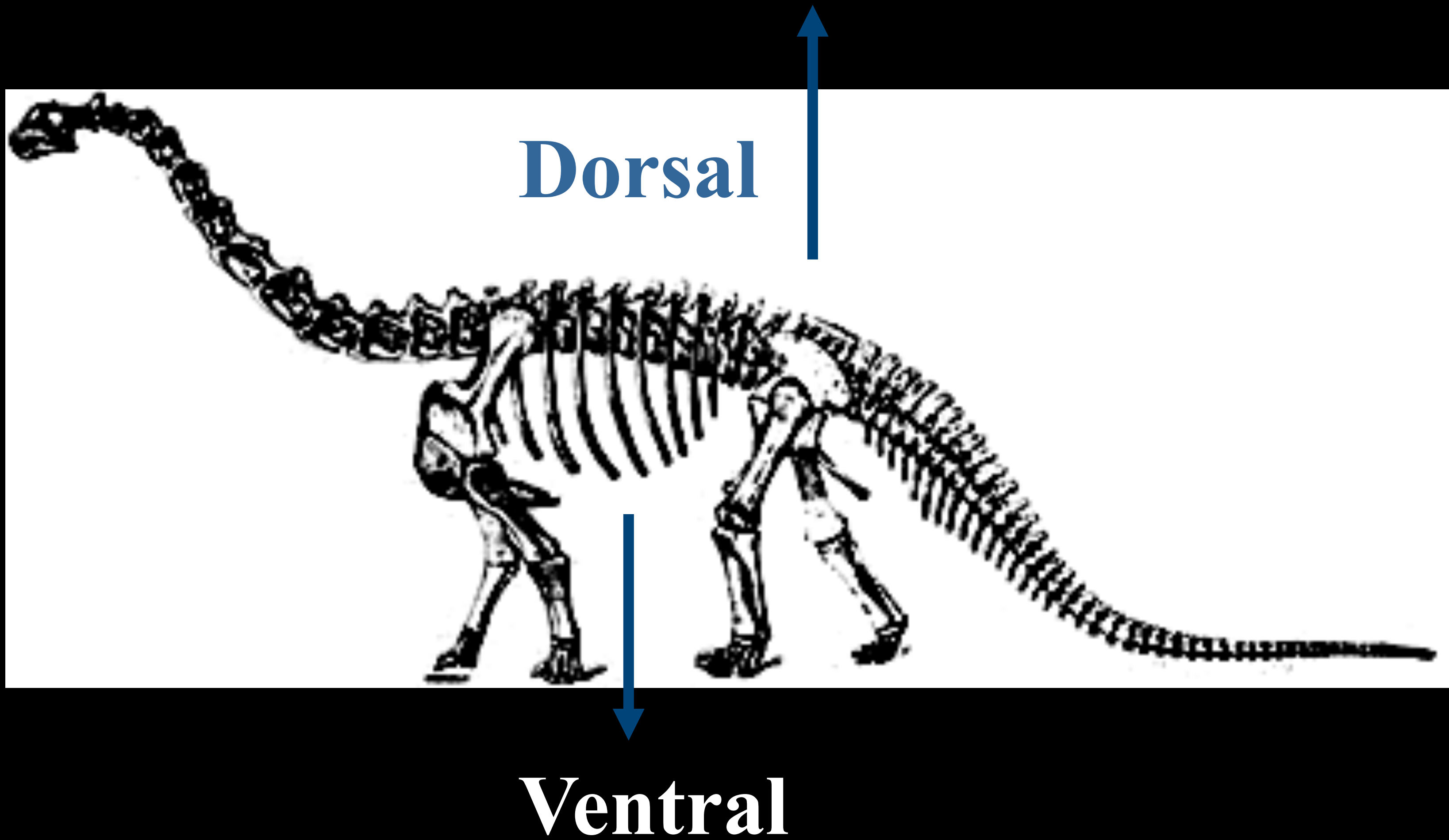
drawing courtesy of Kevin Padian

Homologue bones

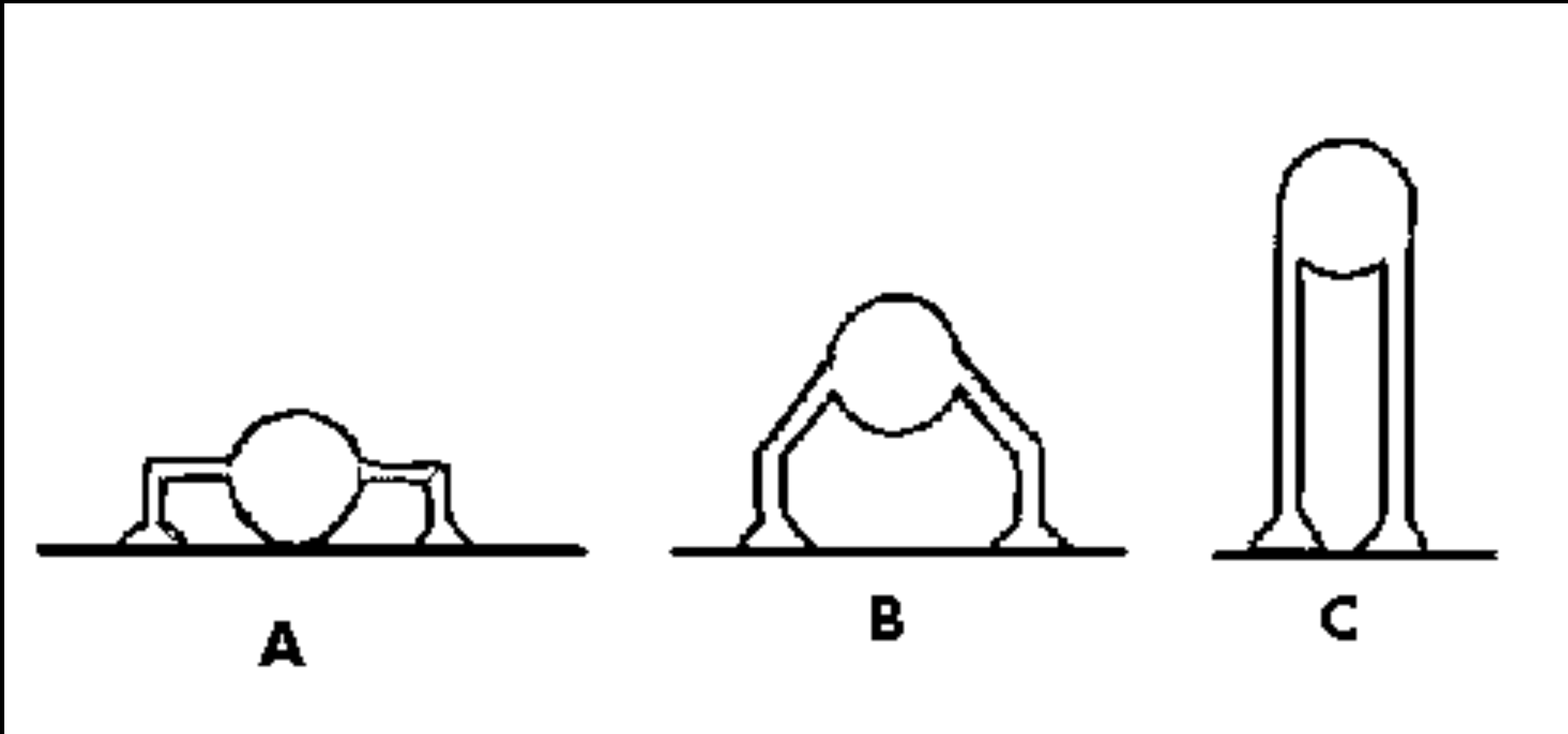




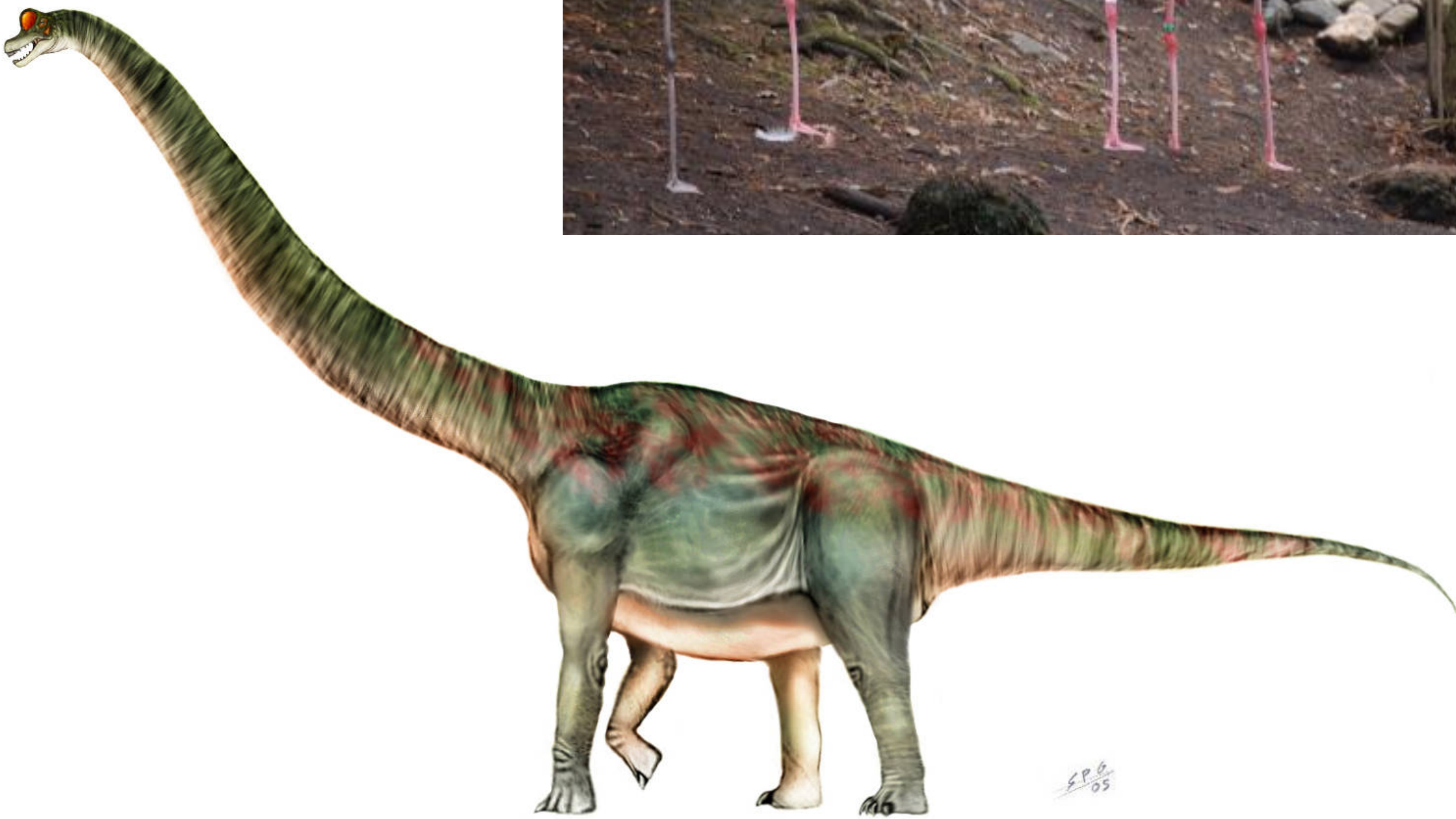

Shoulder girdle
Humerus
Ulna
Radius
Shoulder girdle
Humerus
Radius
Ulna
Humerus
Shoulder girdle
Radius
Ulna
Sarcopterygian
Primitive amphibian
Reptile

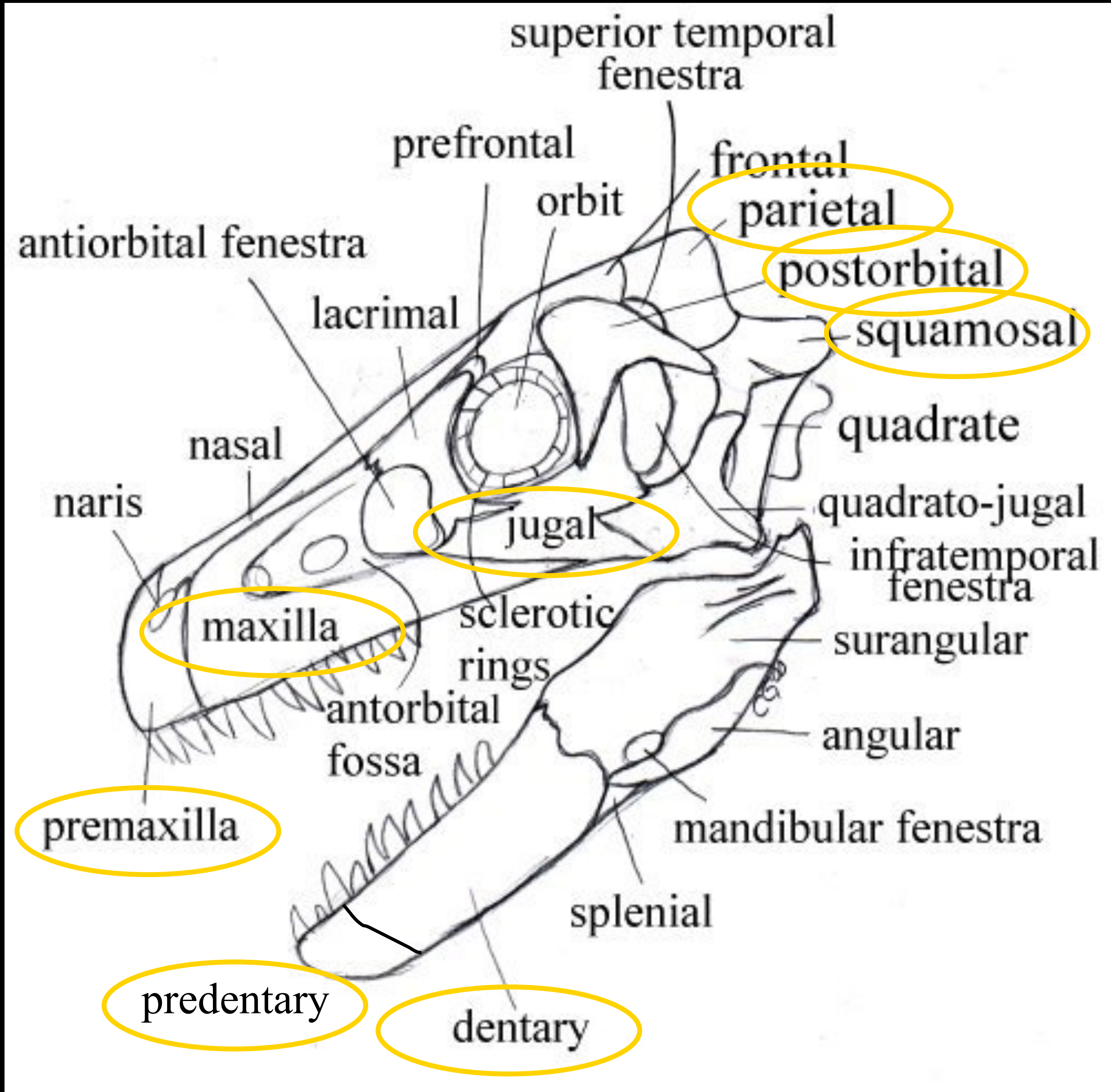

Dorsal
Ventral

- Posture

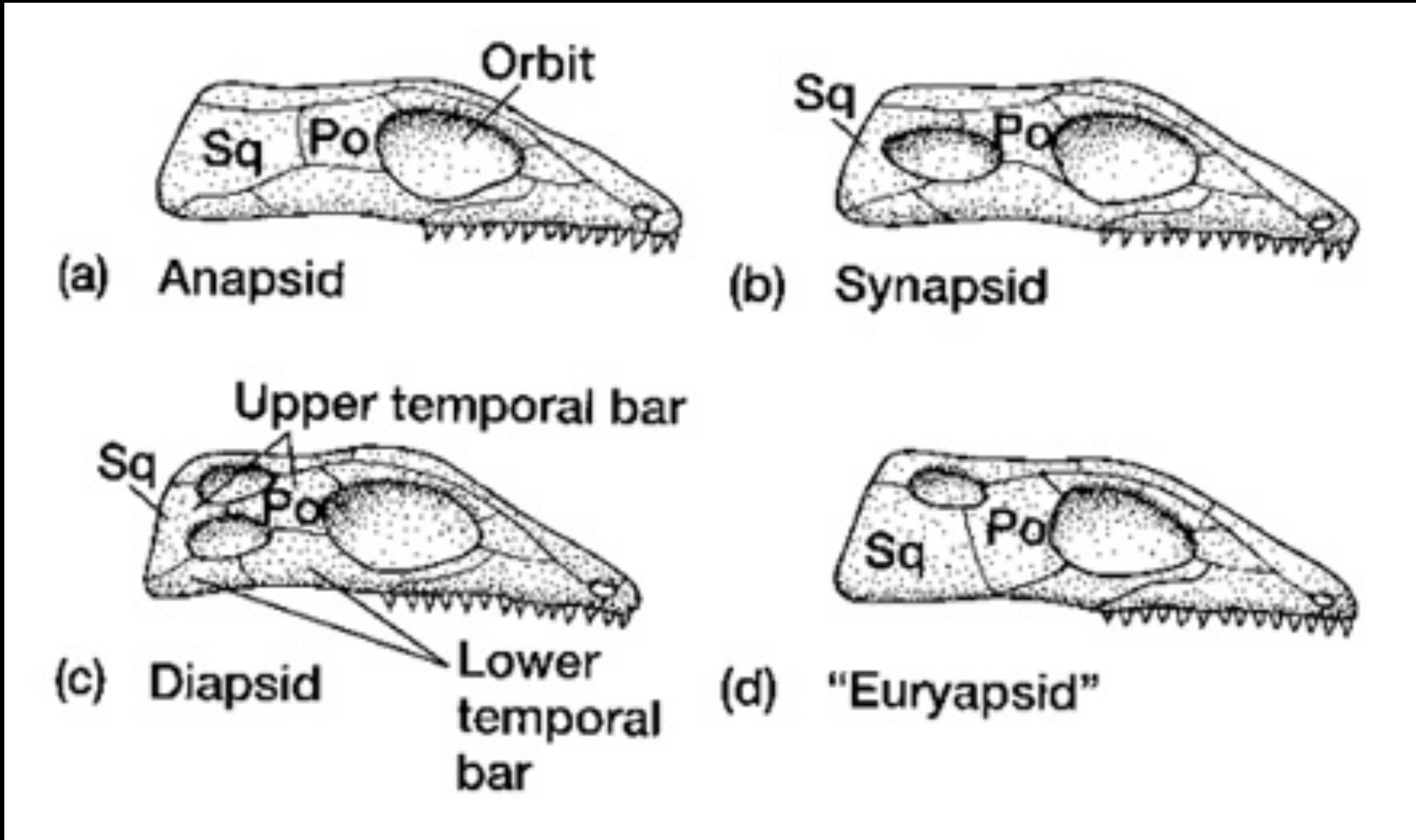


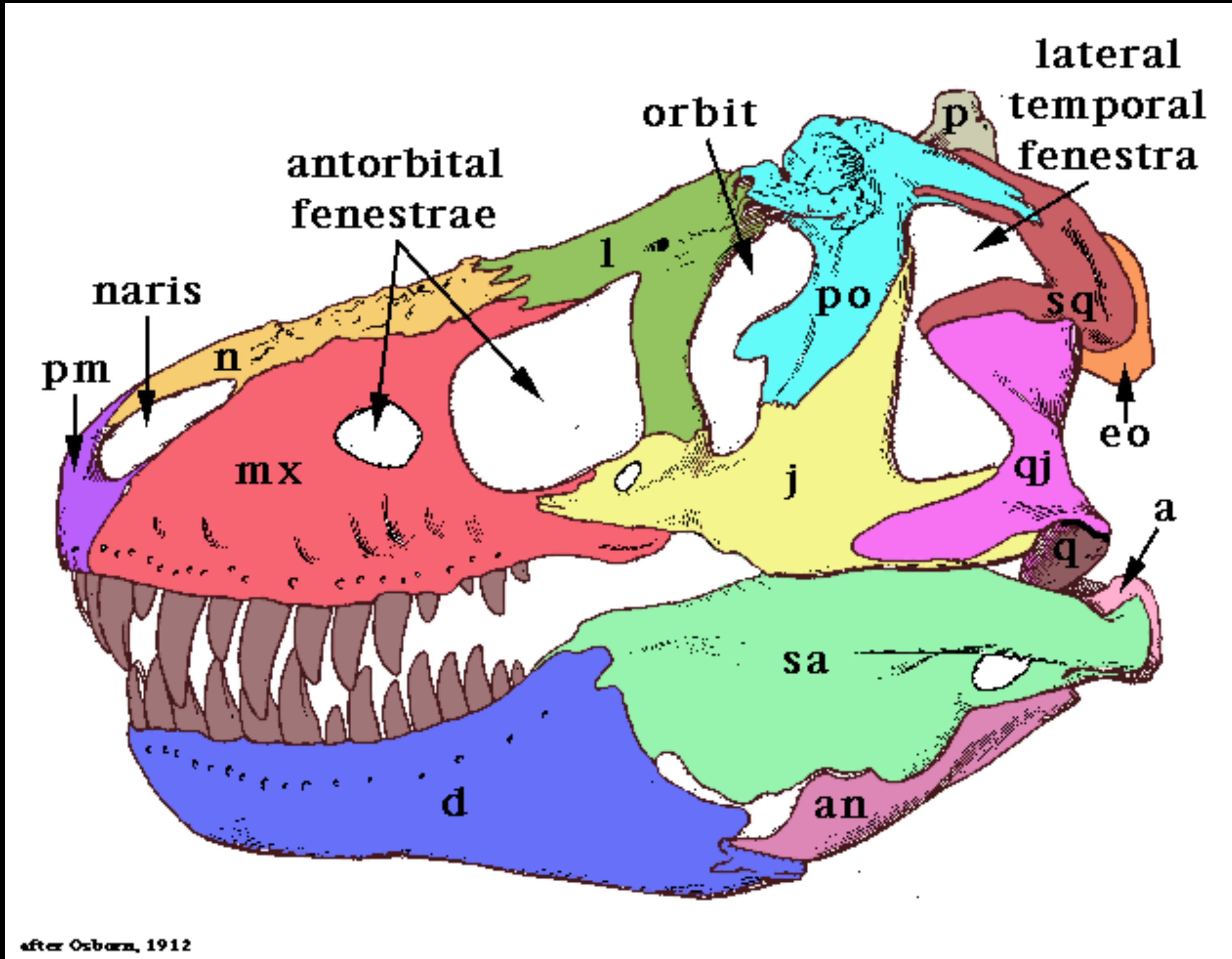
sprawling upright





superior temporal fenestra
prefrontal
frontal
orbit
parietal
antiorbital fenestra
postorbital
lacrimal
squamosal
quadrate
nasal
naris
quadrato-jugal
jugal
infratemporal fenestra
maxilla
sclerotic rings
surangular
antorbital fossa
angular
premaxilla
mandibular fenestra
splenial
predentary
dentary

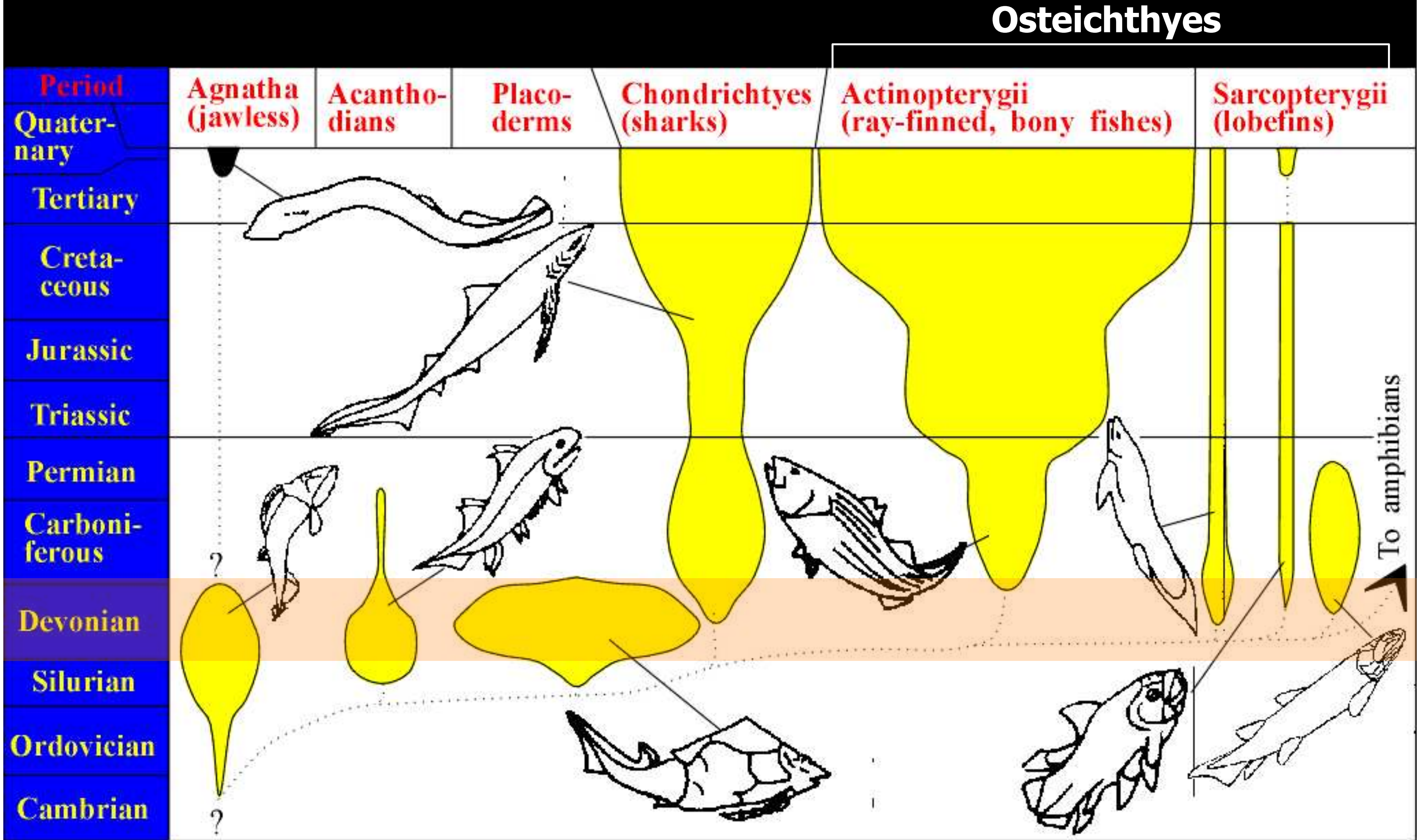

Orbit
Sq
Po
(a) Anapsid
Sq
Po
(b) Synapsid
Upper temporal bar
Sq
Po
(c) Diapsid
Lower temporal bar
Po
Sq
(d) "Euryapsid"



lateral temporal fenestra
orbit
p
antorbital fenestrae
l
po
naris
sq
n
pm
mx
eo
qj
j
a
q
sa
d
an
after Osborn, 1912

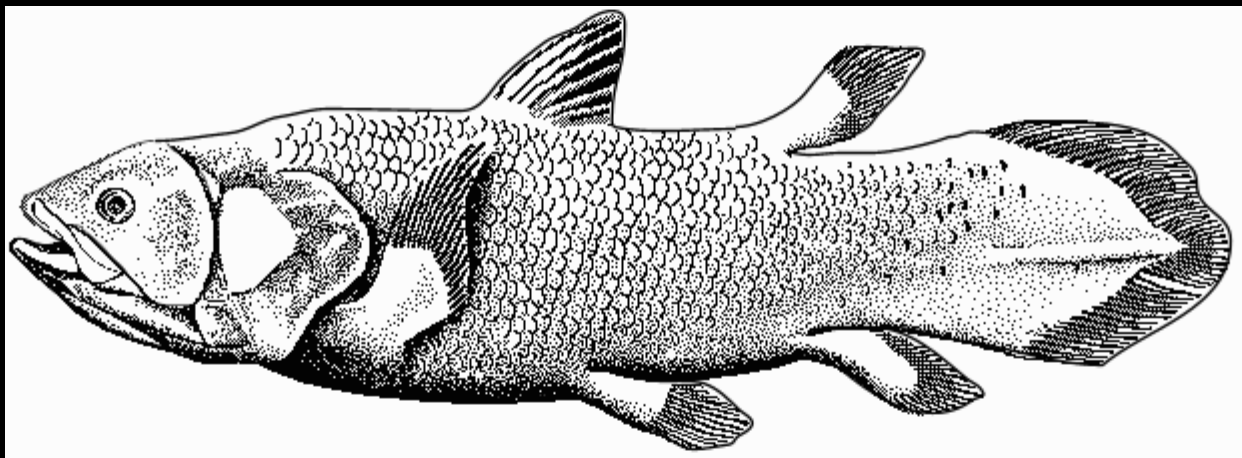
Vertebrates, terrestrial life and the origin of dinosaurs

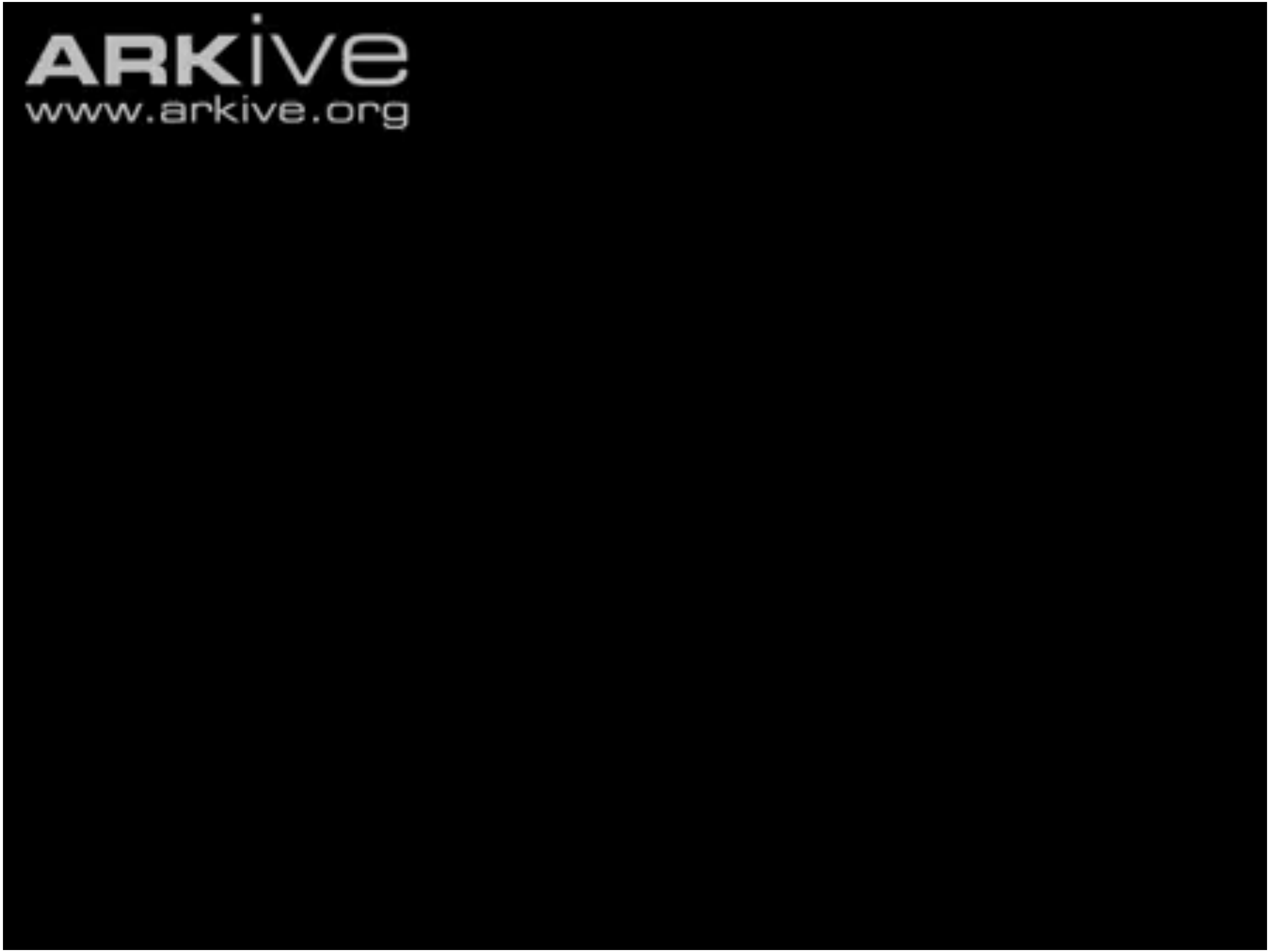
"Fish"


Osteichthyes
Period
Quater-nary
Tertiary
Creta-ceous
Jurassic
Triassic
Permian
Carboni-ferous
Devonian
Silurian
Ordovician
Cambrian
Agnatha (jawless)
Acantho-dians
Placo-derms
Chondrichtyes (sharks)
Actinopterygii (ray-finned, bony fishes)
Sarcopterygii (lobefins)
To amphibians
?
?

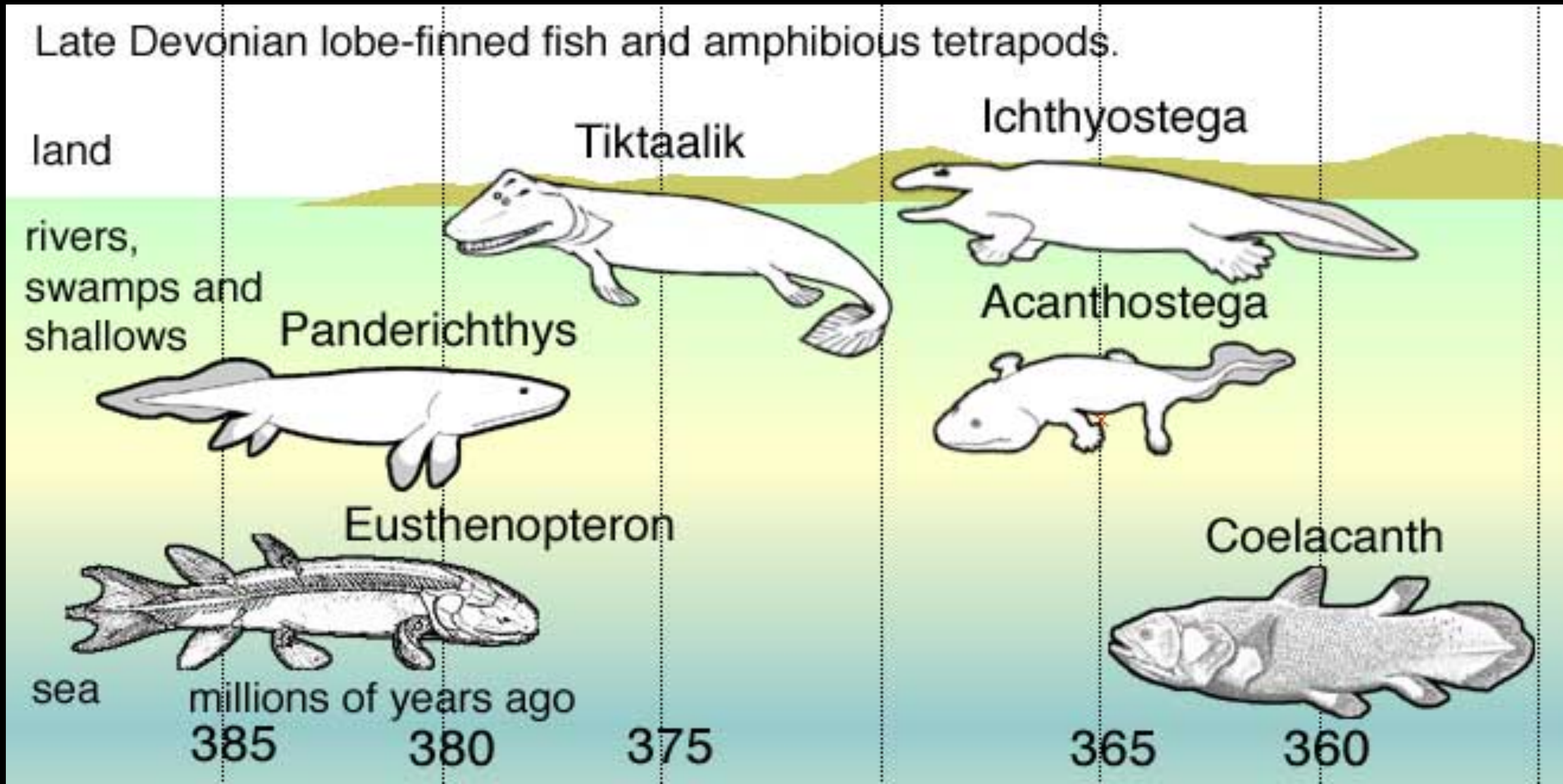
Sarcopterygians
(lungfishes + coelacanths)

- bony fish with paired lobed fins, which are joined to the body by a single bone (→ legs)

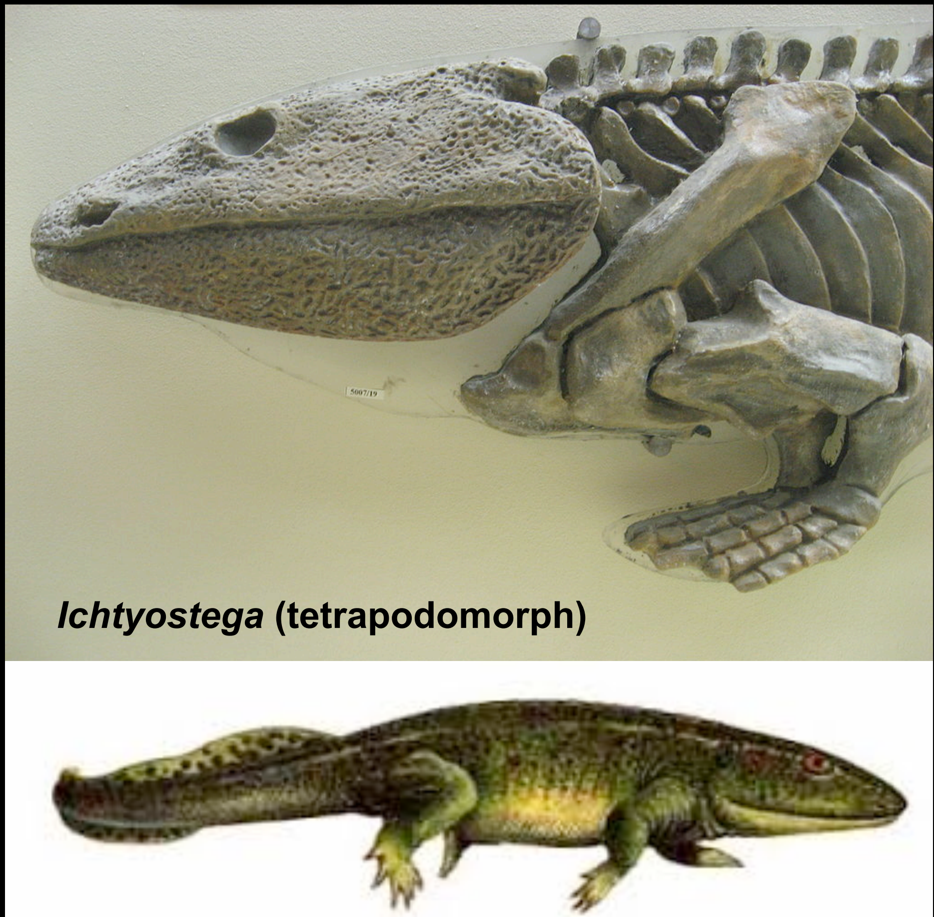



ARKive
www.arkive.org

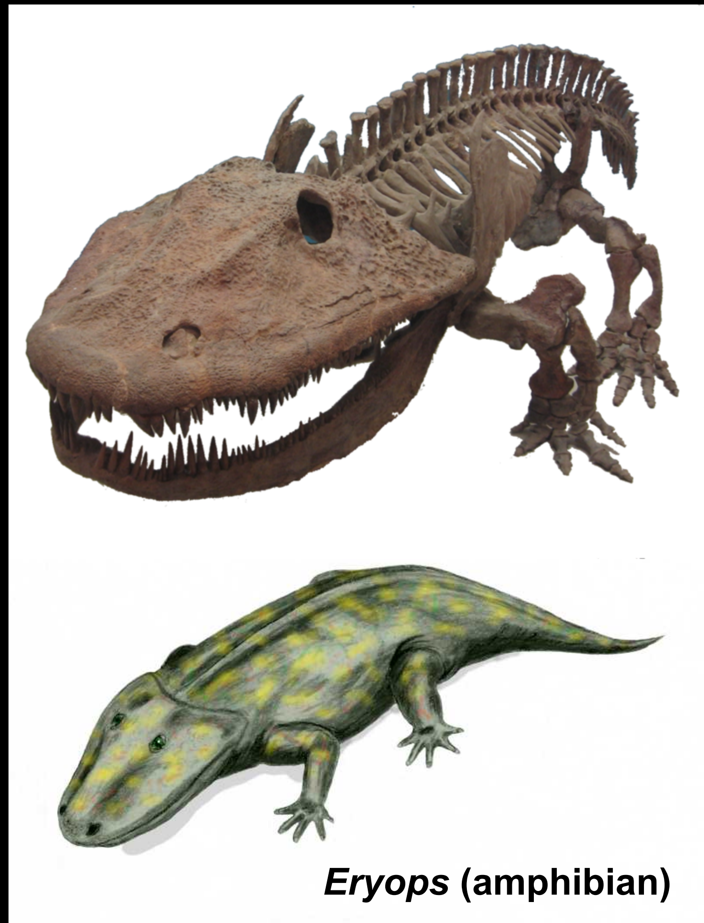
Tetrapodomorpha
(late Devonian)



Life on land



Ichtyostega (tetrapodomorph)

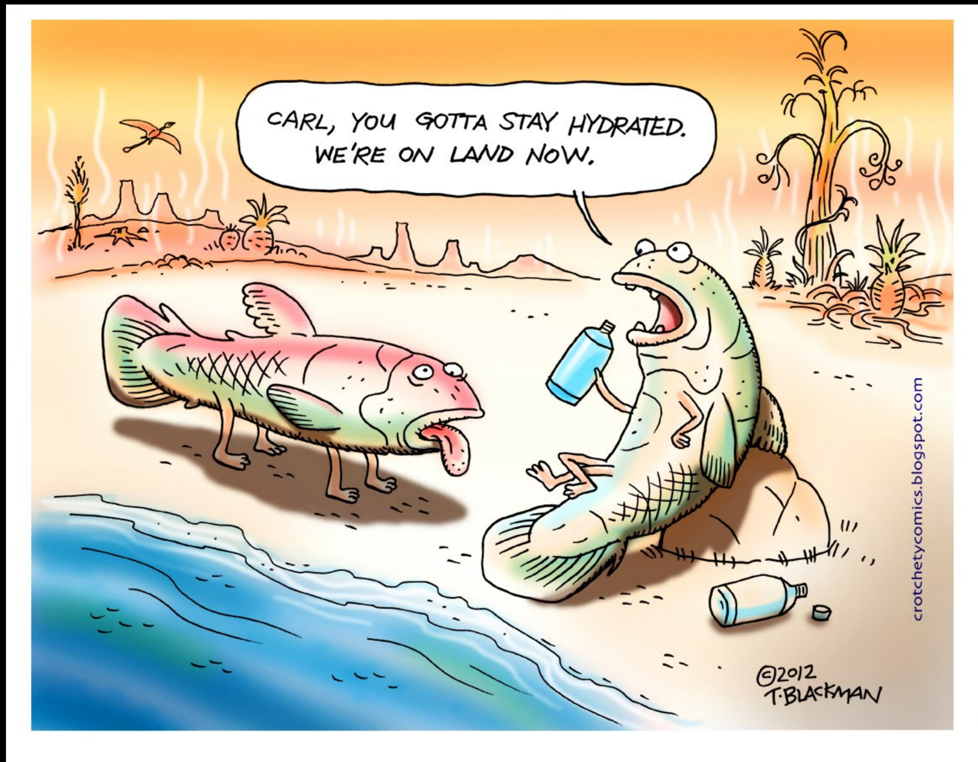


Eryops (amphibian)

→ Problems

Problems with life on land

- air breathing
- weight and structural support
- locomotion
- new ways of feeding
- sensing prey and predators
- water balance
- reproduction



So why go on land?

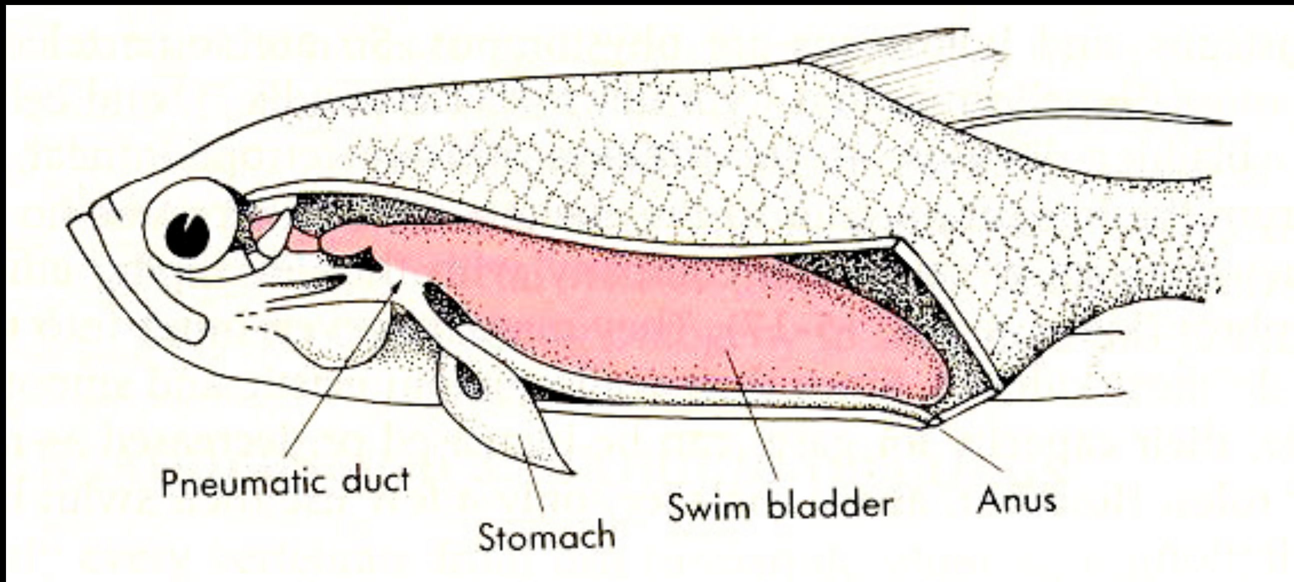
- One theory: escape of droughts
  - → a way to move from pool to pool
  - → going on land was a way to stay in the water

  However, no evidence for droughts

- Second theory: New food supplies
  - → plants and terrestrial invertebrates diversified
  - → "Fish" were following the food

Solutions to life on land

- air breathing
  - → lungs (probably already developed when still in water; lungs similar to modern lungfish)
  - → lungs are homologue to swim bladders of fish



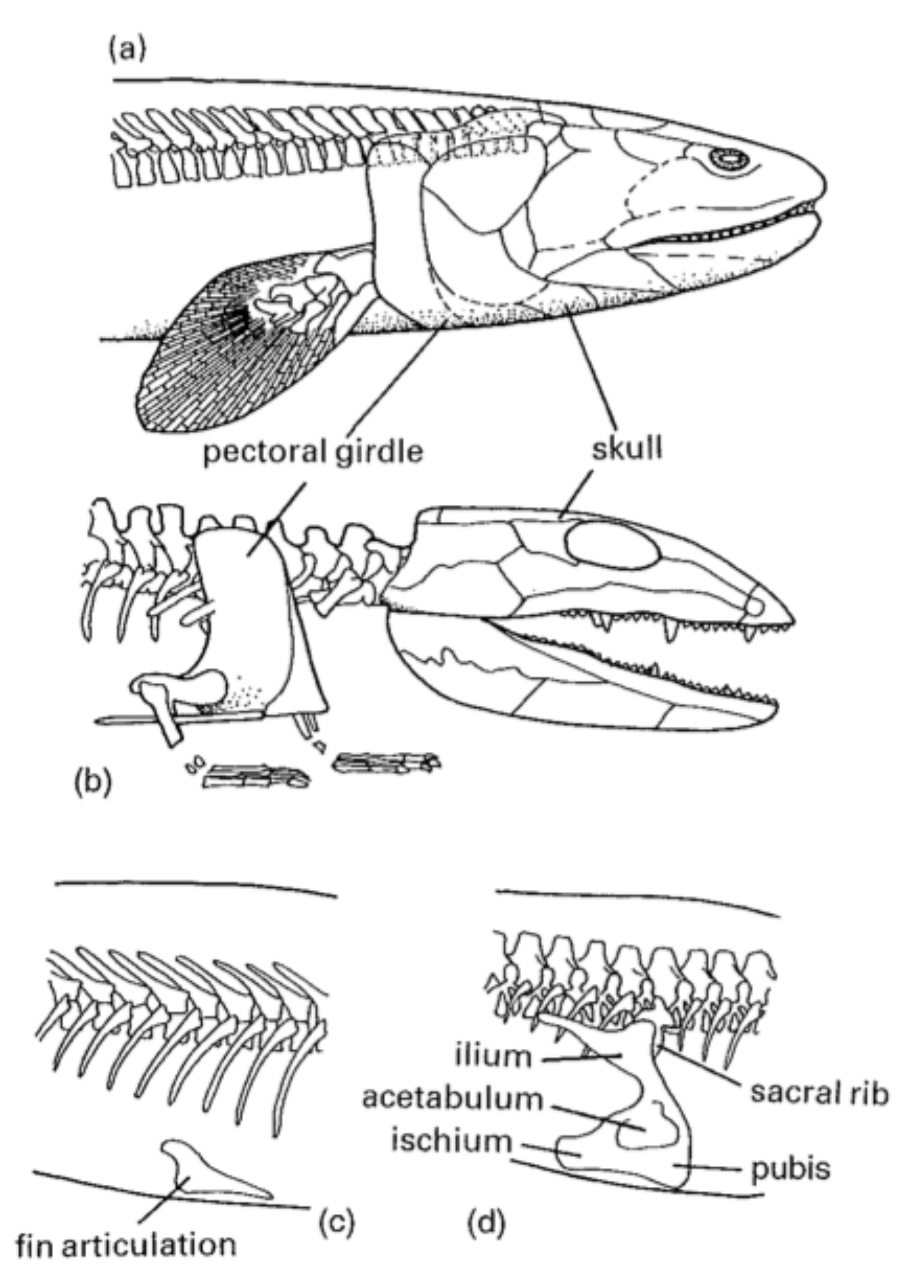
swim bladder /simple air sac) → subdivision of sac into many small sacs → proper lungs

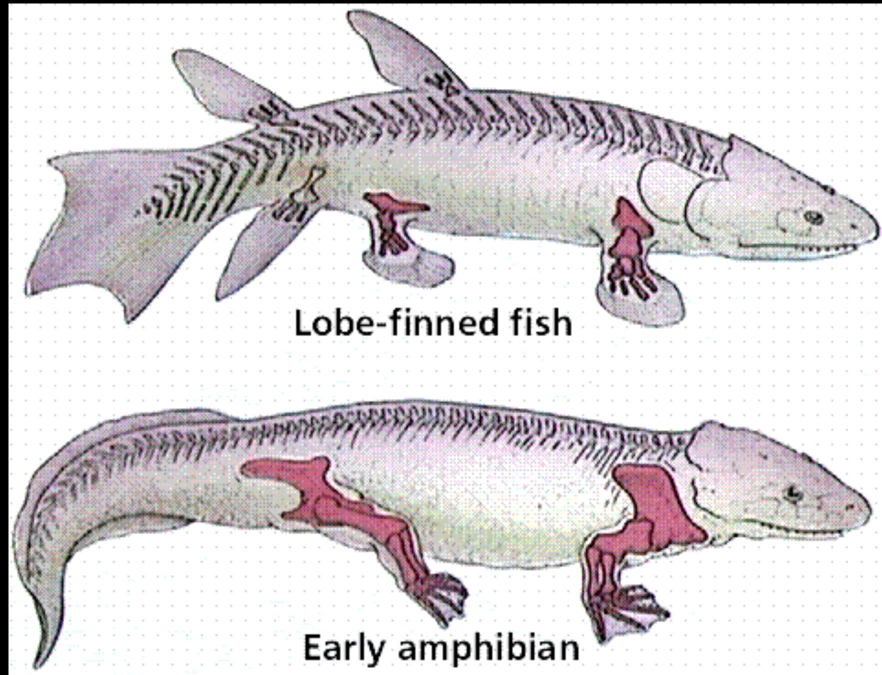
"fish" → **lungfish, tetrapodomorphs** → **tetrapods**

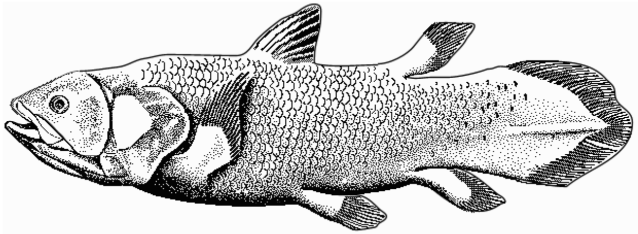
Solutions to life on land

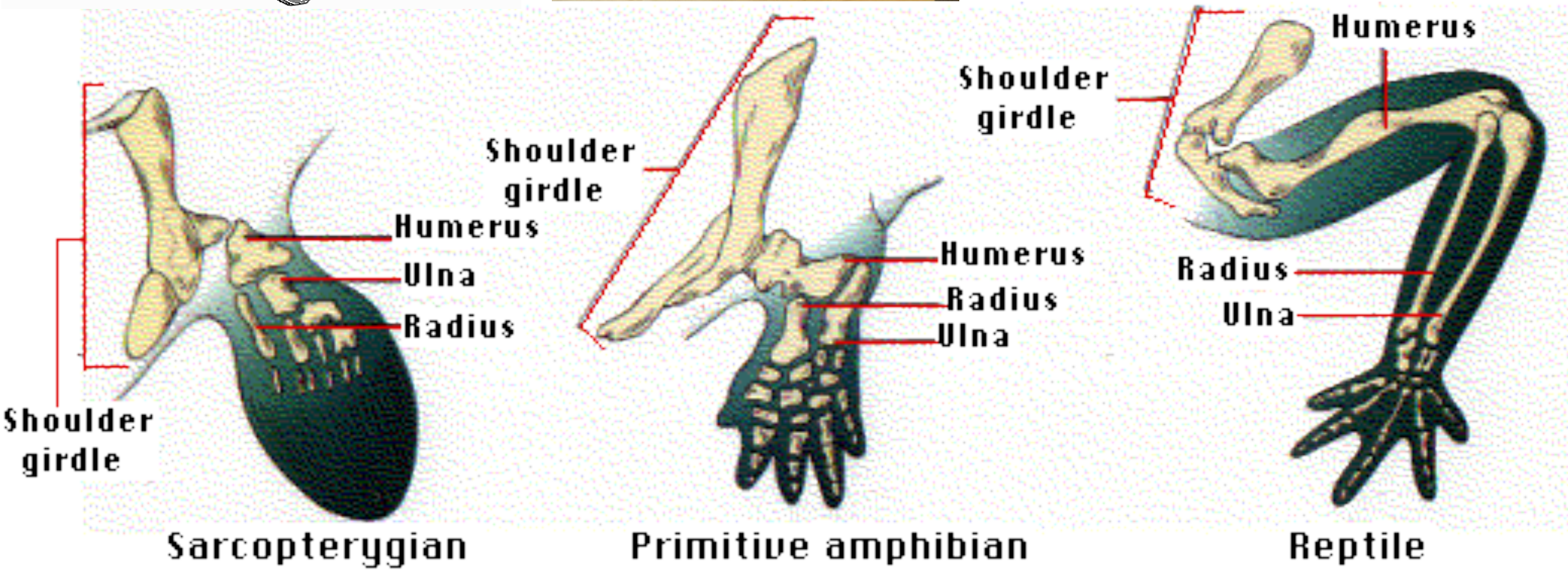
- weight and structural support
  - → Development of shoulder and hip girdle
- locomotion
  - → new bones (phalanges -> weight support)
  - → more defined joints (elbow, wrist)
  - → lengthening of humerus

Hip and shoulder girdle







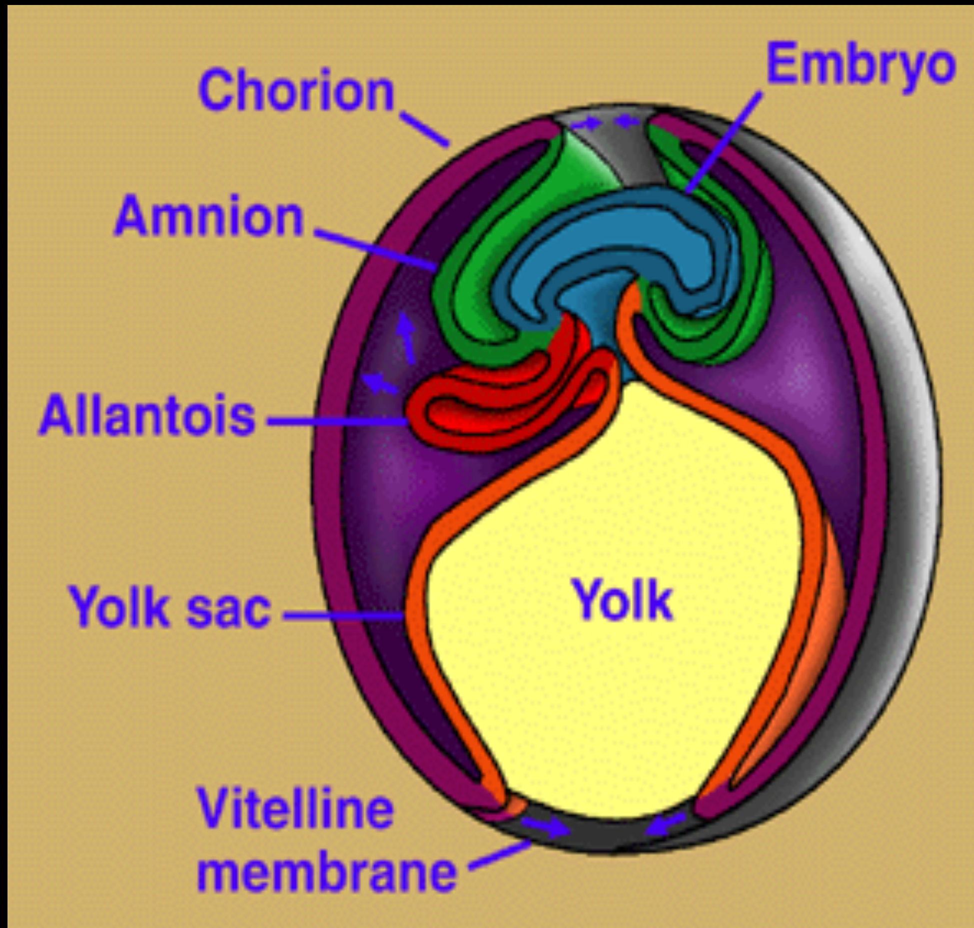

Shoulder girdle
Humerus
Ulna
Radius
Sarcopterygian
Shoulder girdle
Humerus
Radius
Ulna
Primitive amphibian
Humerus
Shoulder girdle
Radius
Ulna
Reptile

Solutions to life on land

- new ways of feeding
  - → skull became stiffer; lower jaw hinges at one point
- sensing prey and predators
  - → lateral line system does not work on land
  - → eyes became larger
- water balance (risk of desiccation as water evaporates)
  - → stay close to water
  - → development of semipermeable skin coverings (=scales)
- reproduction
  - → like ancestors and modern amphibians
  - → amniotic egg and internal fertilization

Amniota

- Eggs with amnion
  - membranes that allowed oxygen exchange but prevented dessication

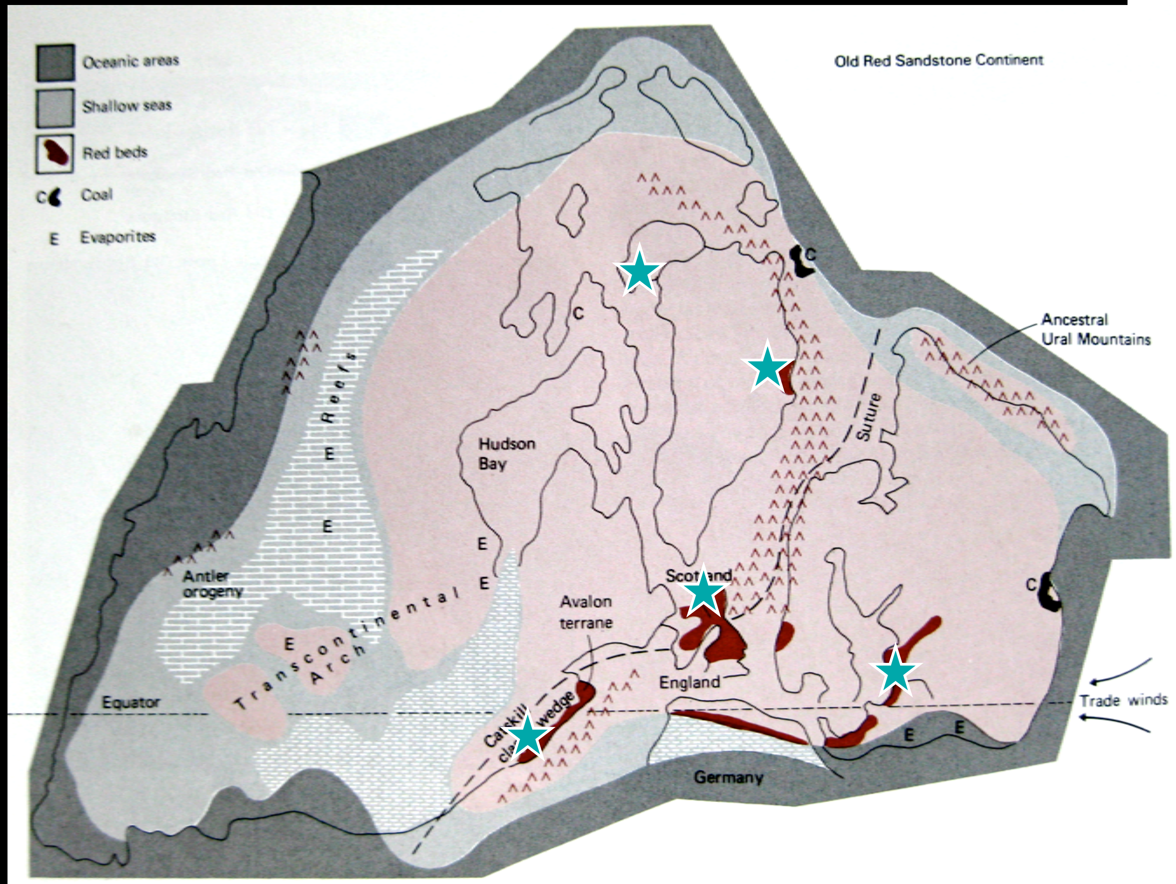


Amniota vs. “fish” and Amphibia

First tetrapods

many late Devonian localities

- Scotland (*Elginerpeton*)
- Latvia (*Vantastega*)
- China (*Sinerpeton*)
- North America (*Hynerpeton*)
- Greenland (*Acanthostega, Ichthyostega*)
- Canada (*Tiktaalik*)



- First amphibians (Devonian)

Ichthyostega (Upper Devonian)

Acanthostega (Upper Devonian)

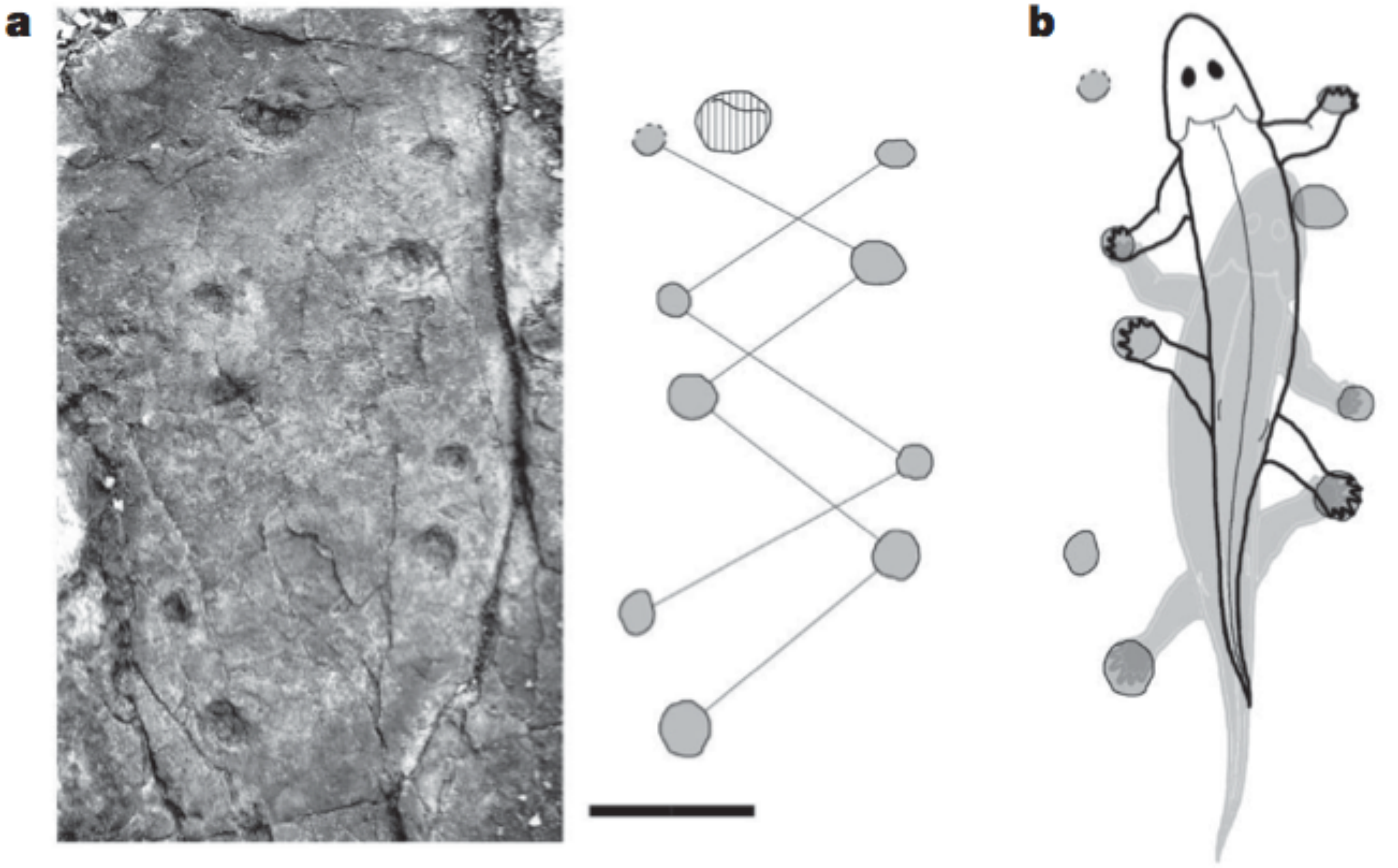
Vol 463 | 7 January 2010 | doi:10.1038/nature08623

ARTICLES

Tetrapod trackways from the early Middle Devonian period of Poland

Grzegorz Niedźwi

The fossil record of
trackways. The earl
transitional elpisto
predating these boc
we present well-pre
Devonian (Eifelian
million years earlie
environmental setti



The first ”reptiles” = first amniots

Hylonomus

- since Carboniferous
- small, lizard-like
- insect eaters