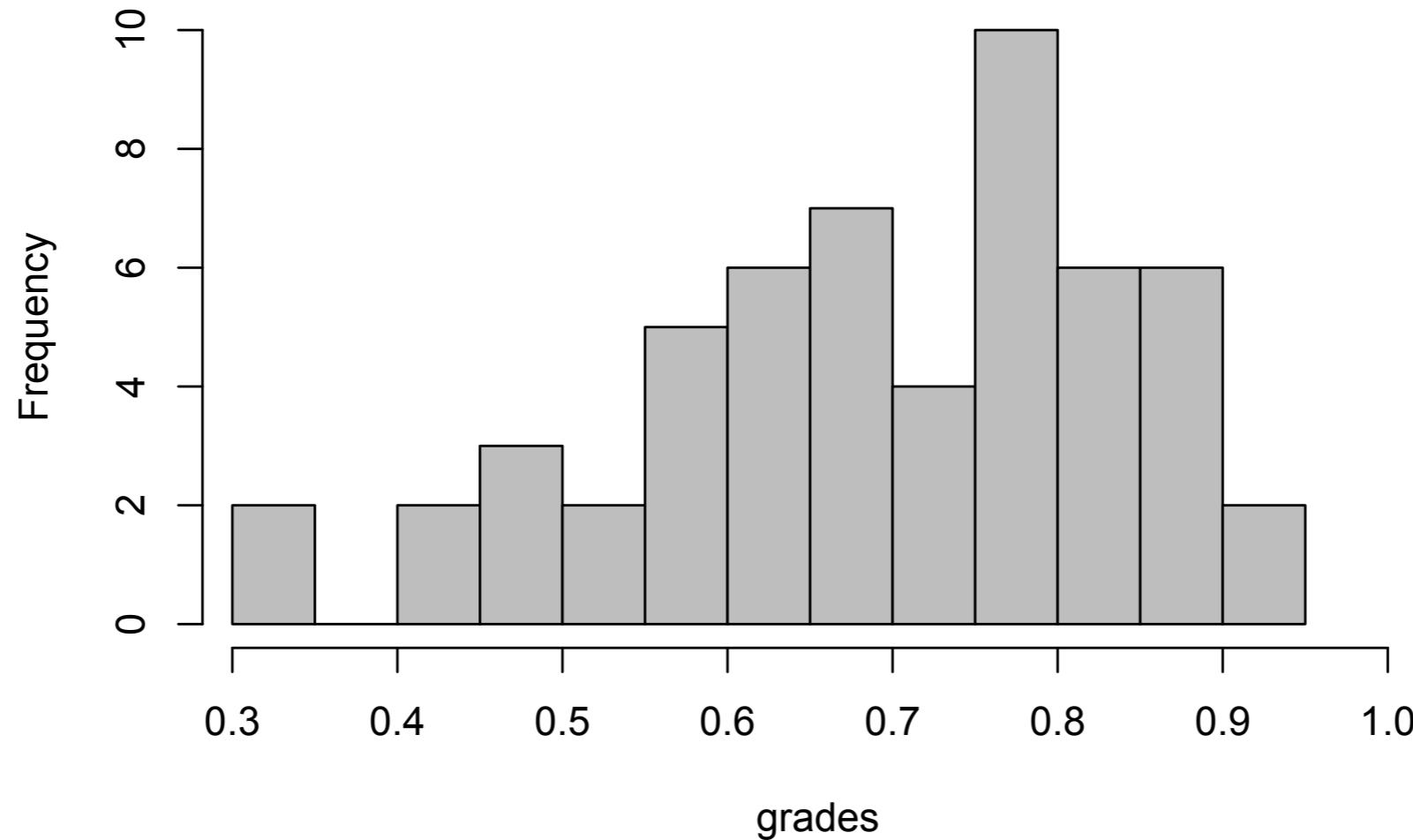
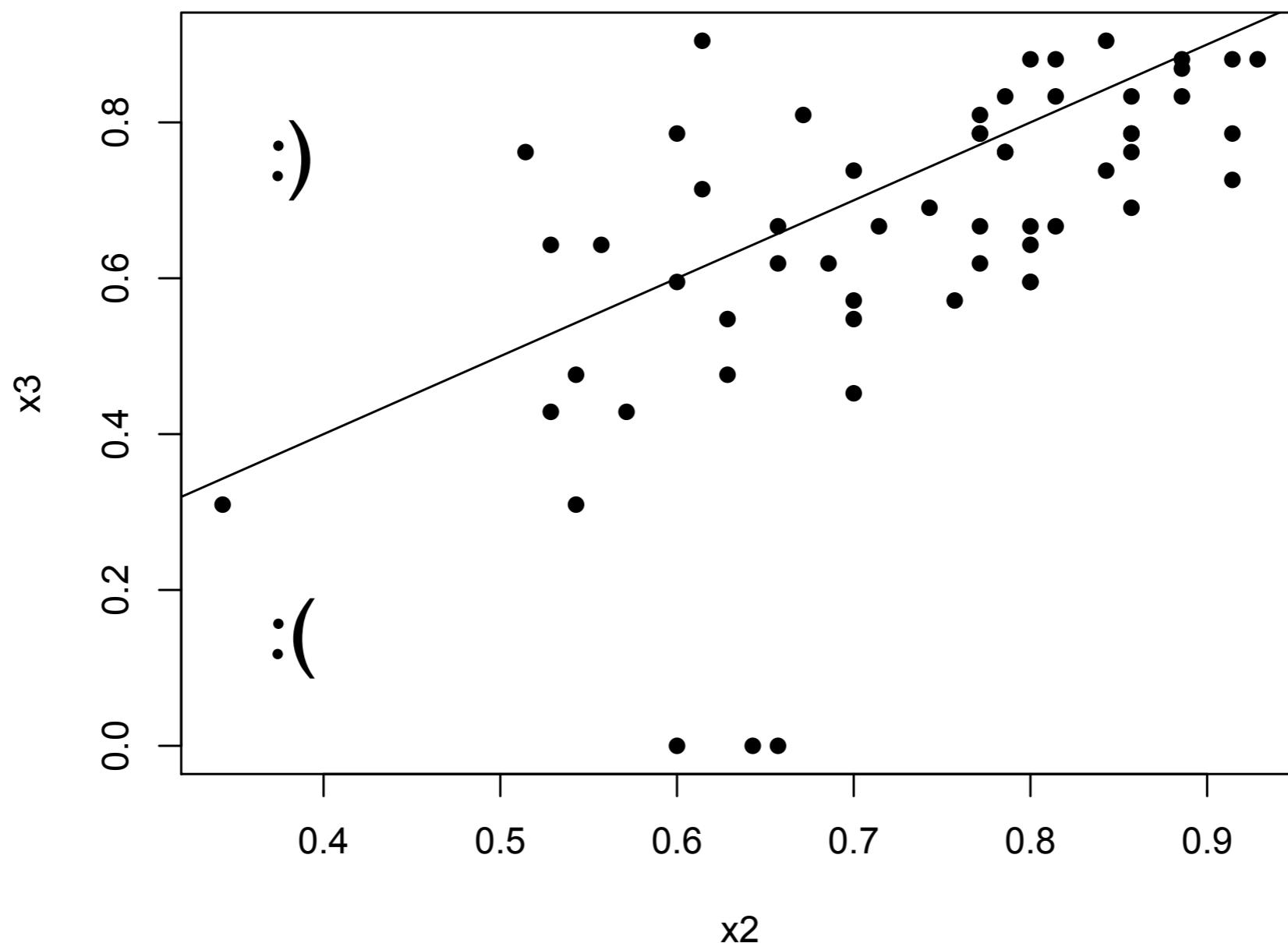
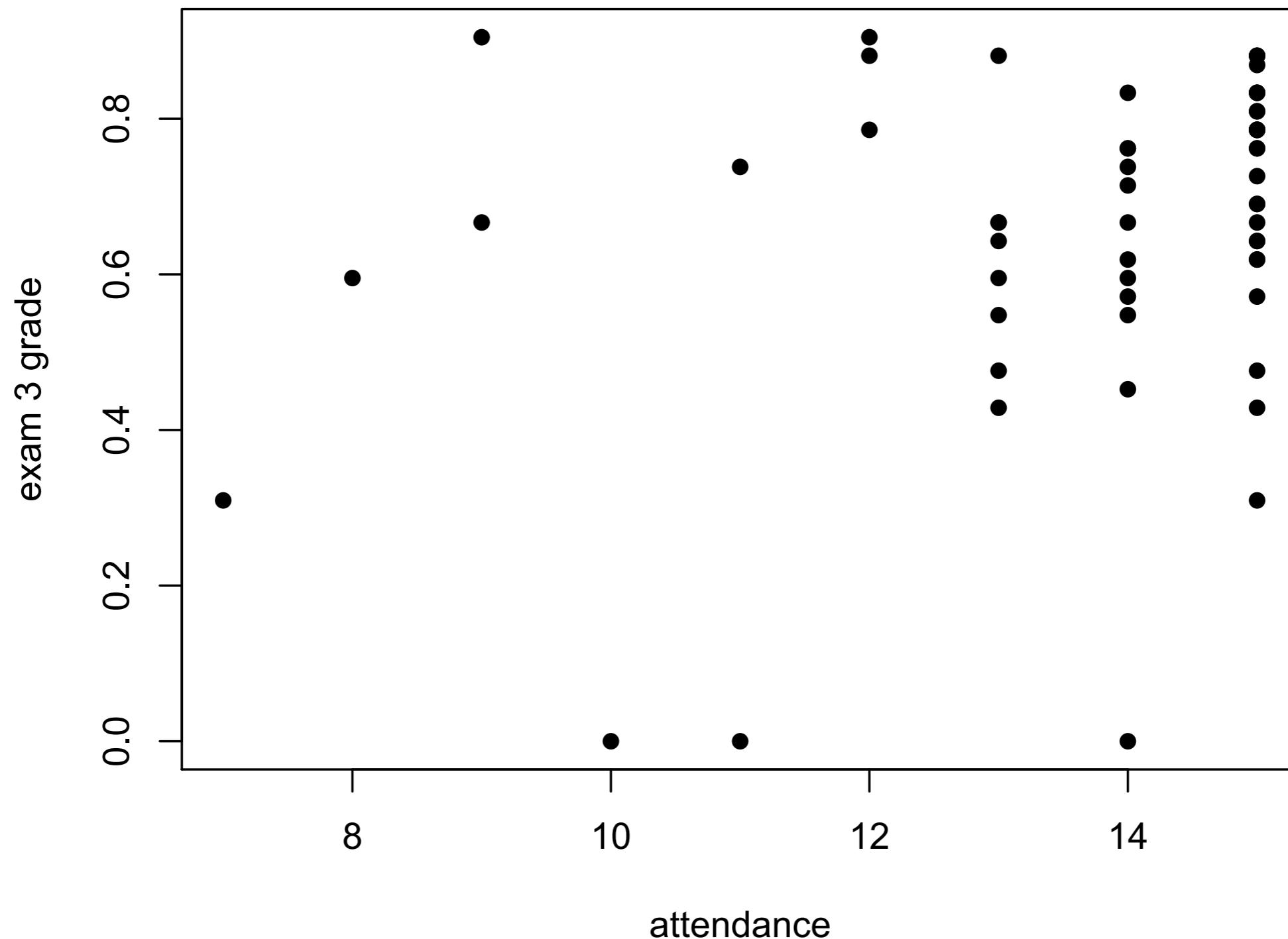


Histogram of x3adj



Mean: 69%





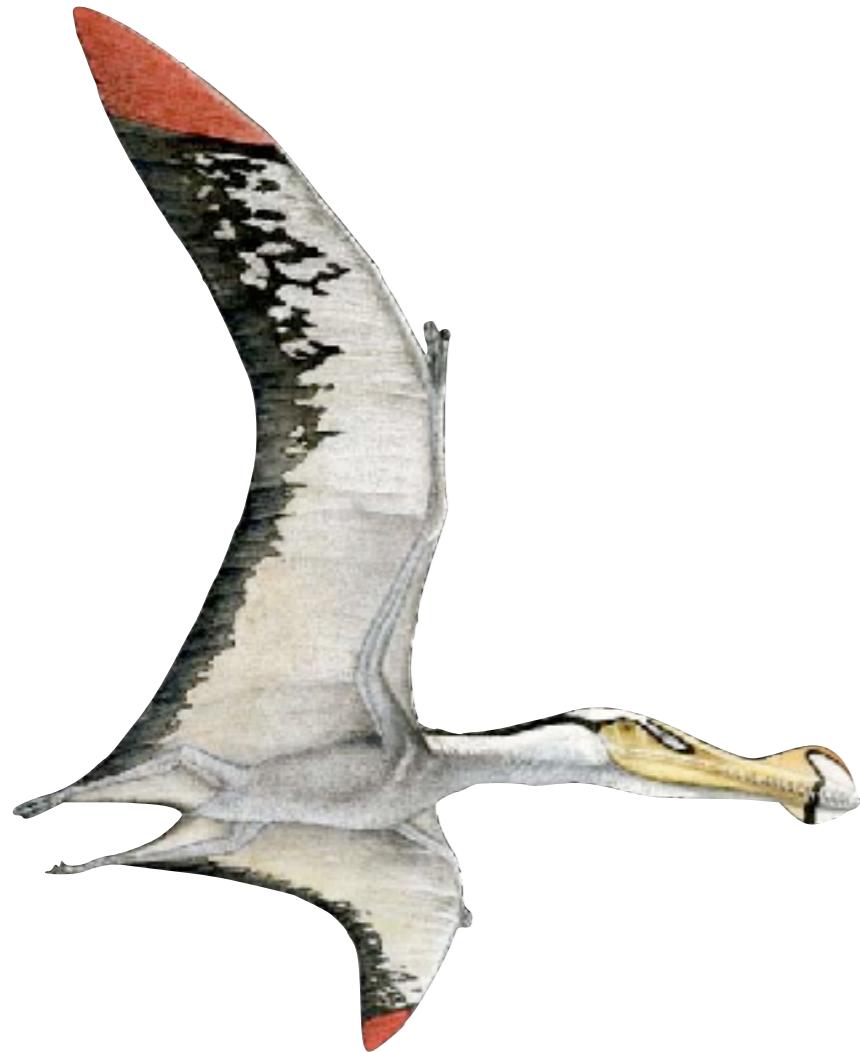
Flying Reptiles of the Mesozoic



Bird Evolution Summary

- Birds are theropod dinosaurs, demonstrated by similarities in osteology, oology, integument, and behavior
- Feathers and arm flapping evolved **before** the animals were capable of powered flight
- Flight likely first evolved in paravian theropods (not in birds), but they were poor fliers
- Further acquisition of flight adaptations (pygostyle, sternum, alula) occurred during Mesozoic bird evolution

Pterosauria



Earliest vertebrates known to evolve
powered flight!

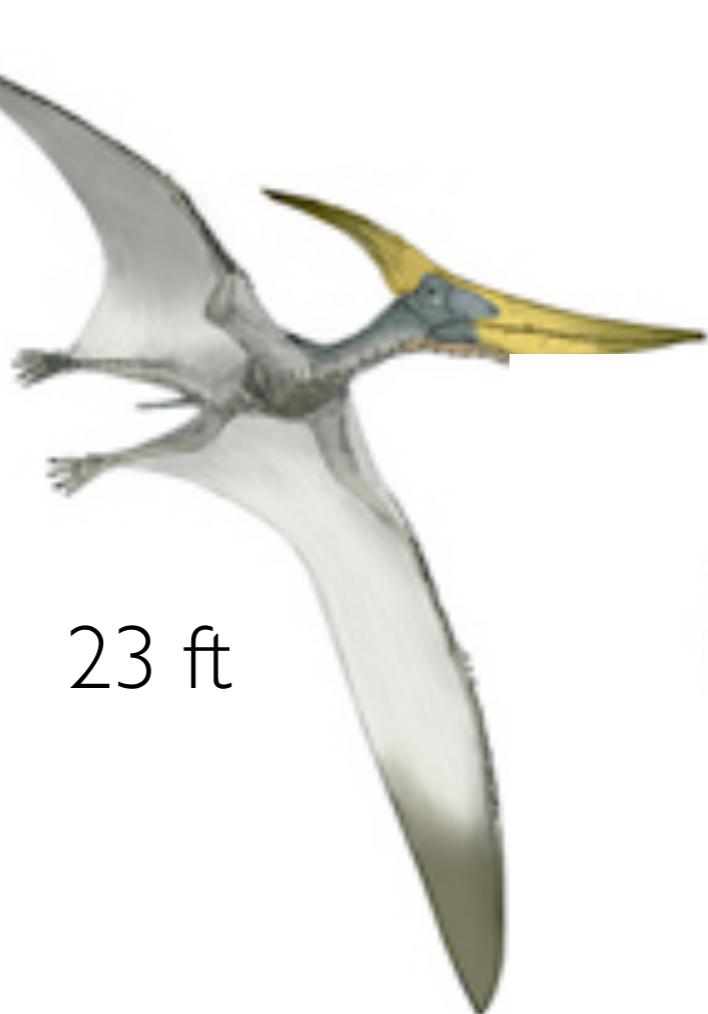
Pterosauria



10 in



23 ft



33 ft

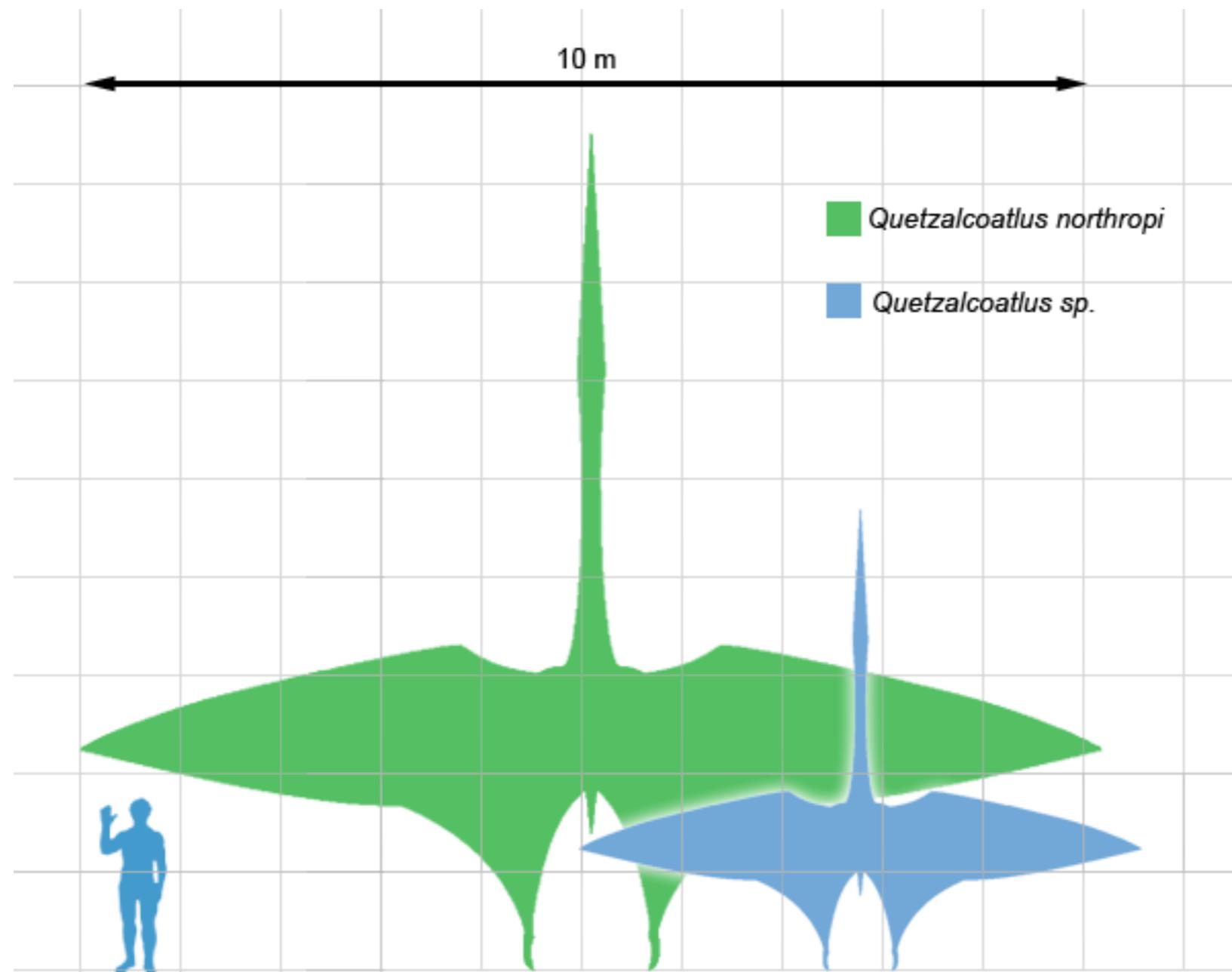


Quetzalcoatlus



13 ft





Pterosauria: early forms

Late Triassic - Late Jurassic

Eudimorphodon: (sea gull sized)

Already an advanced flyer

Short body

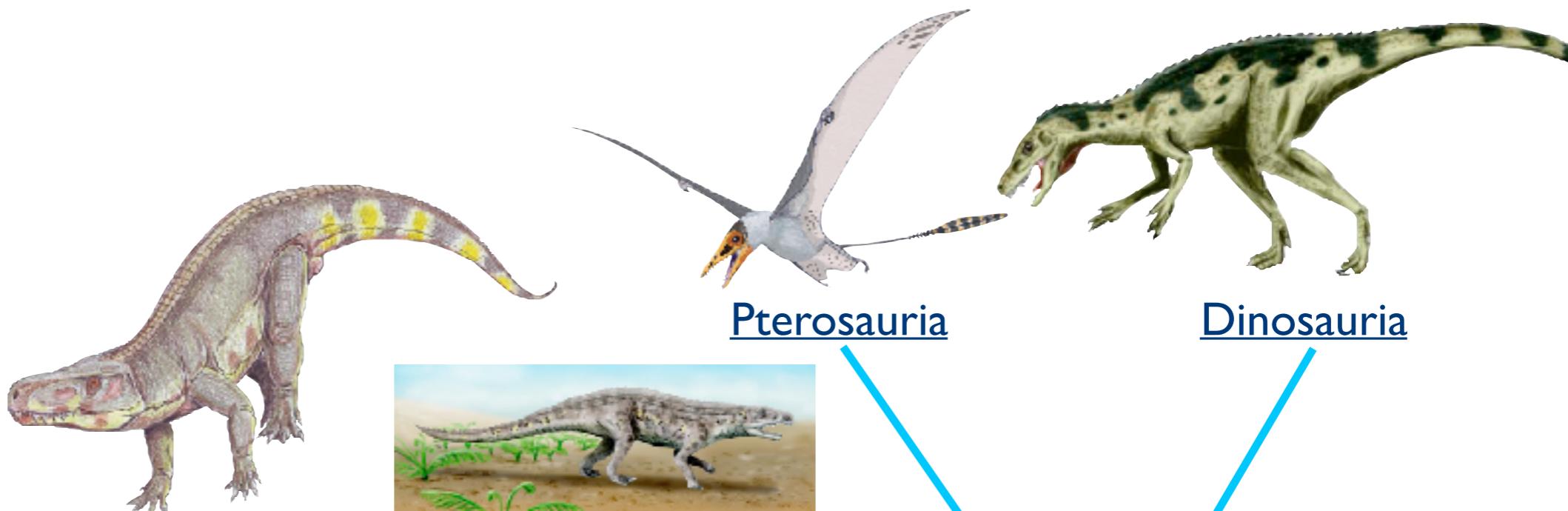
Elongate 4th finger

Pteroid bone





Crocodylomorpha



“Rauisuchia”

Ornithosuchidae

Pterosauria

Dinosauria

Ornithodira

Crurotarsi

Basal archosaurs

Crown-clade Archosauria

Archosauria

Pterosauria



Scleromochlus



Pterosauria



Lagosuchus



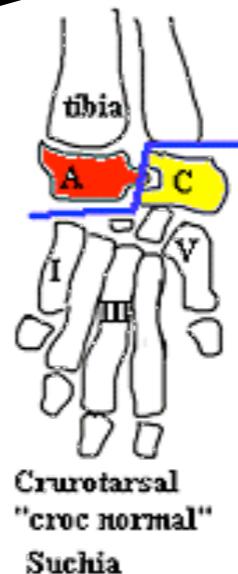
Aves



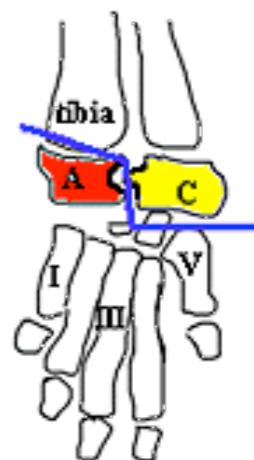
Dinosauria



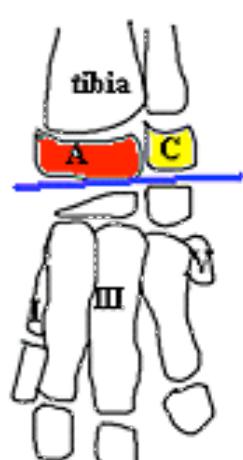
Ornithodira:
Upright gait
S-curved necks
Hinged Ankle



Crurotarsal
"croc normal"
Suchia

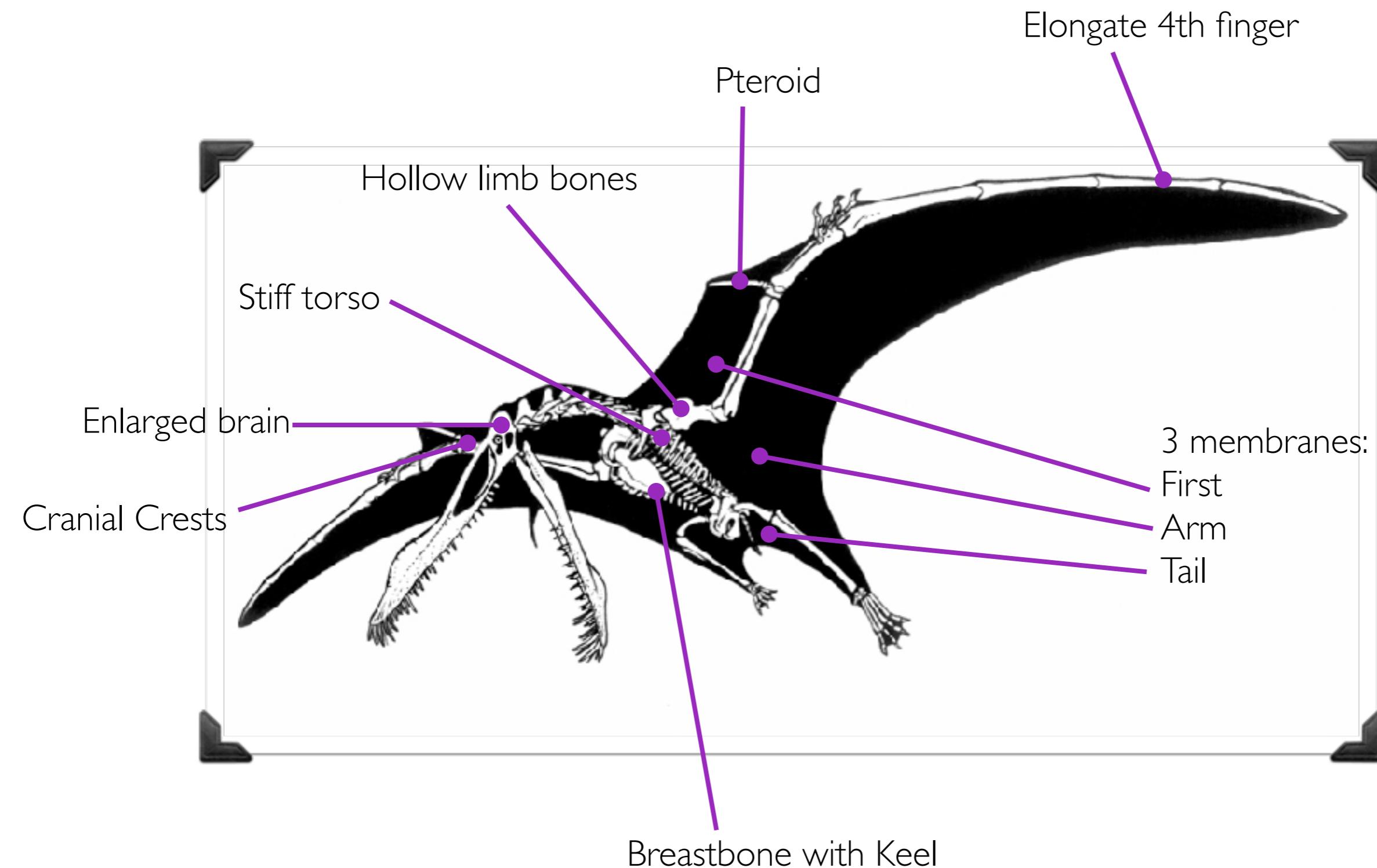


Crurotarsal
"croc reversed"
Ornithosuchia

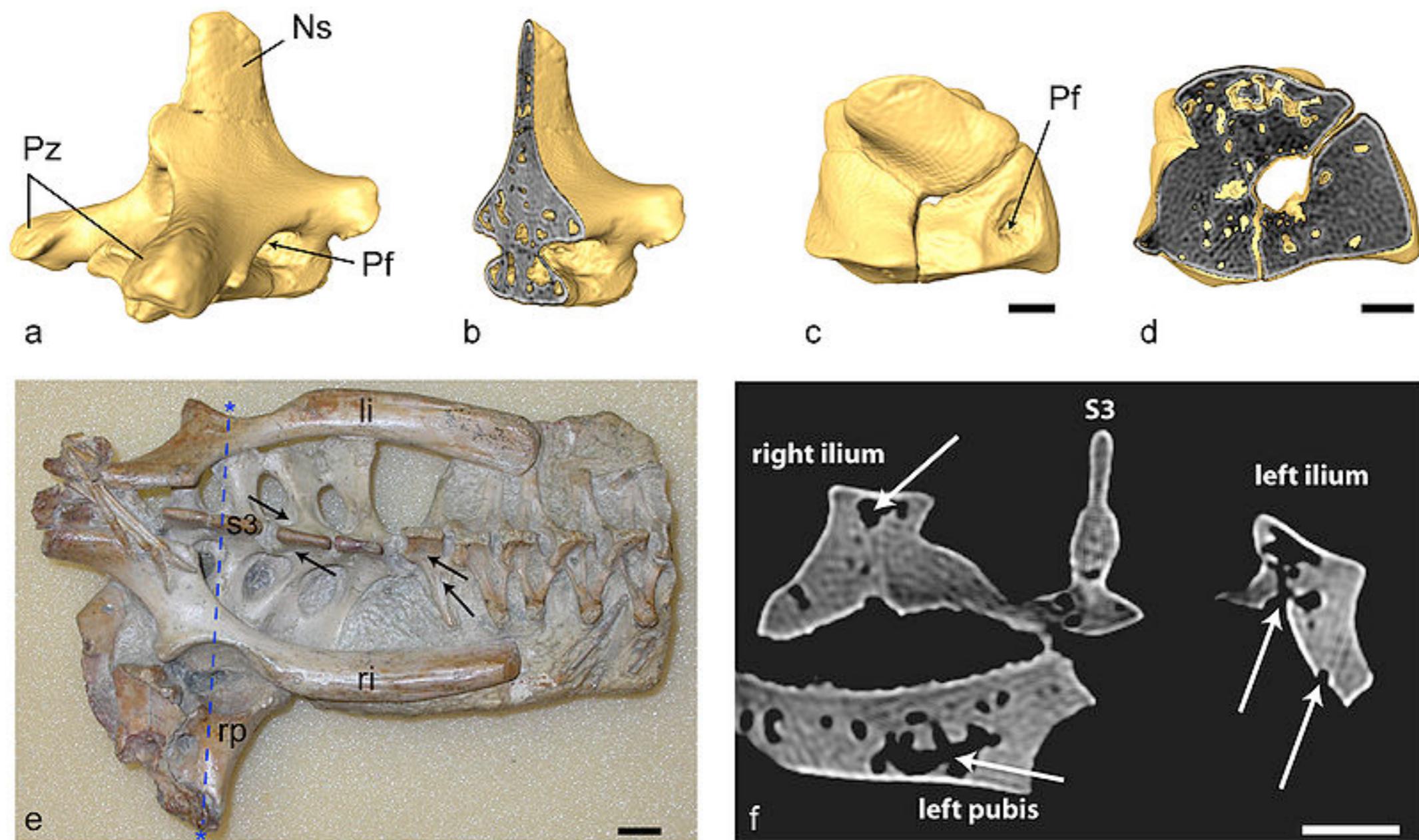


Mesotarsal
Ornithodira

Pterosaur Traits



Pterosaur Traits: pneumatic bones



Pterosaur Traits: air sacs



Pterosaur Traits: cranial crests

Keratinous



Pteranodon



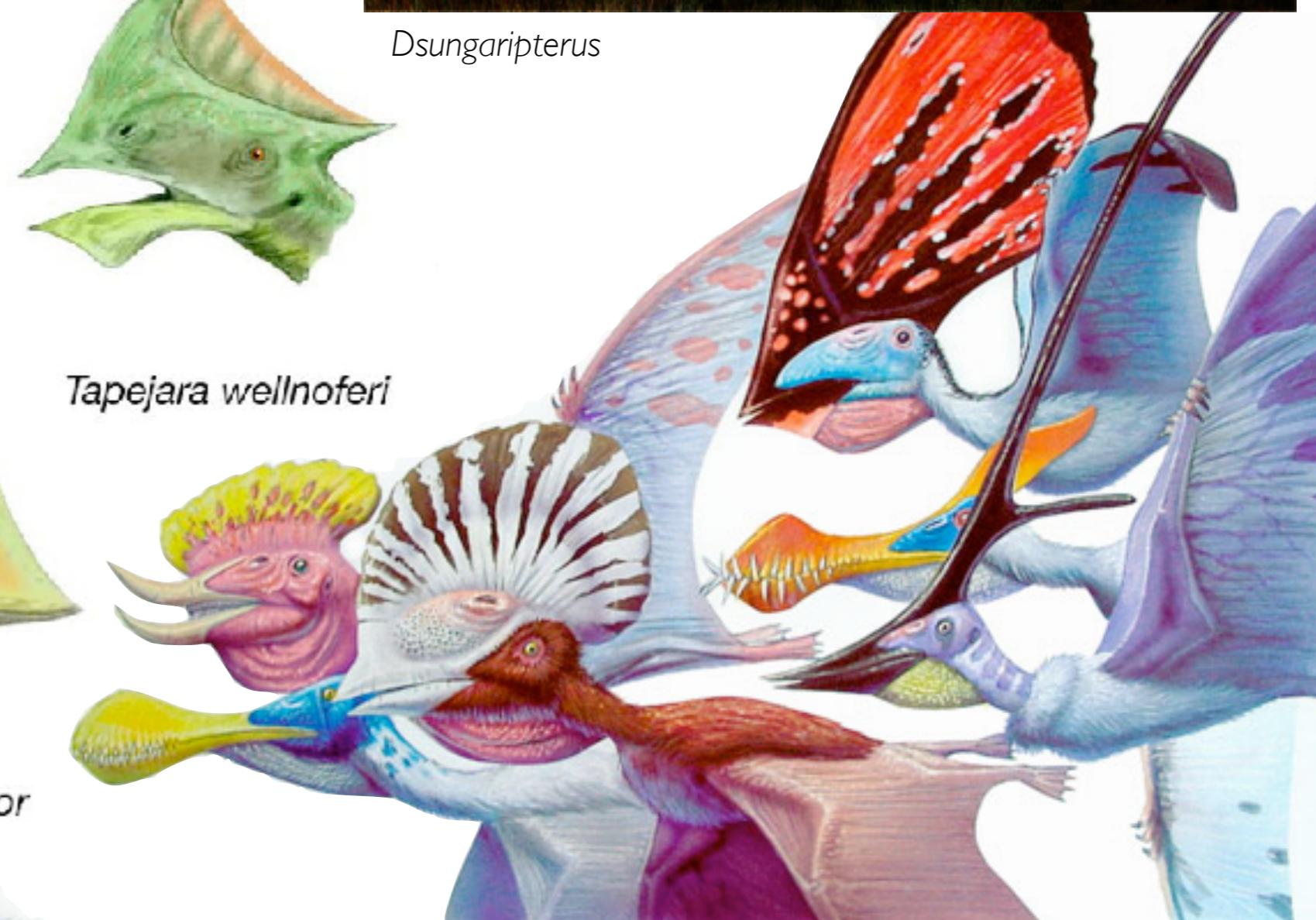
"*Ingridia*" *navigans*



Tupandactylus imperator



Tapejara wellnoferi



Dsungaripterus

Pterosaur Traits: cranial crests

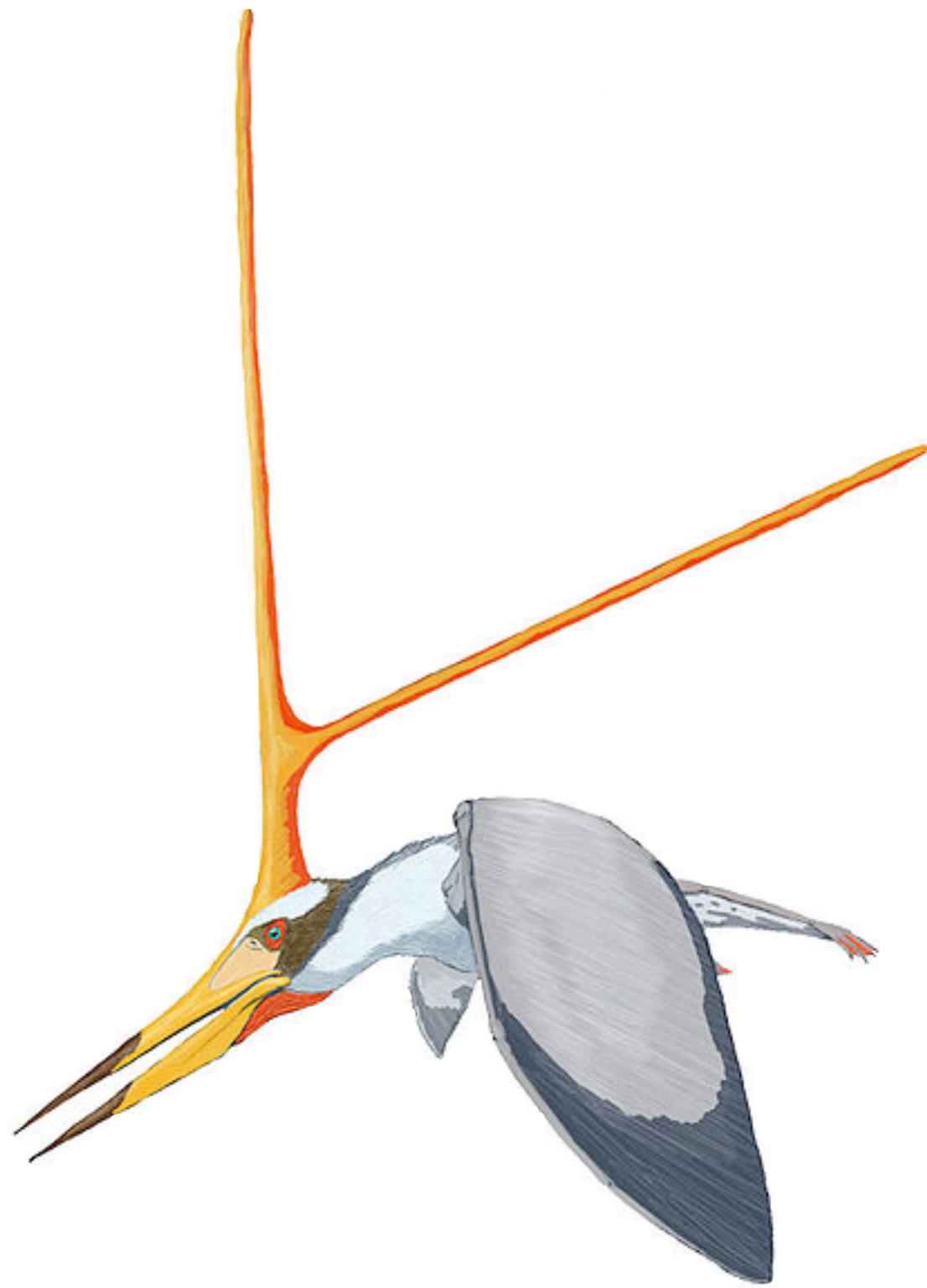
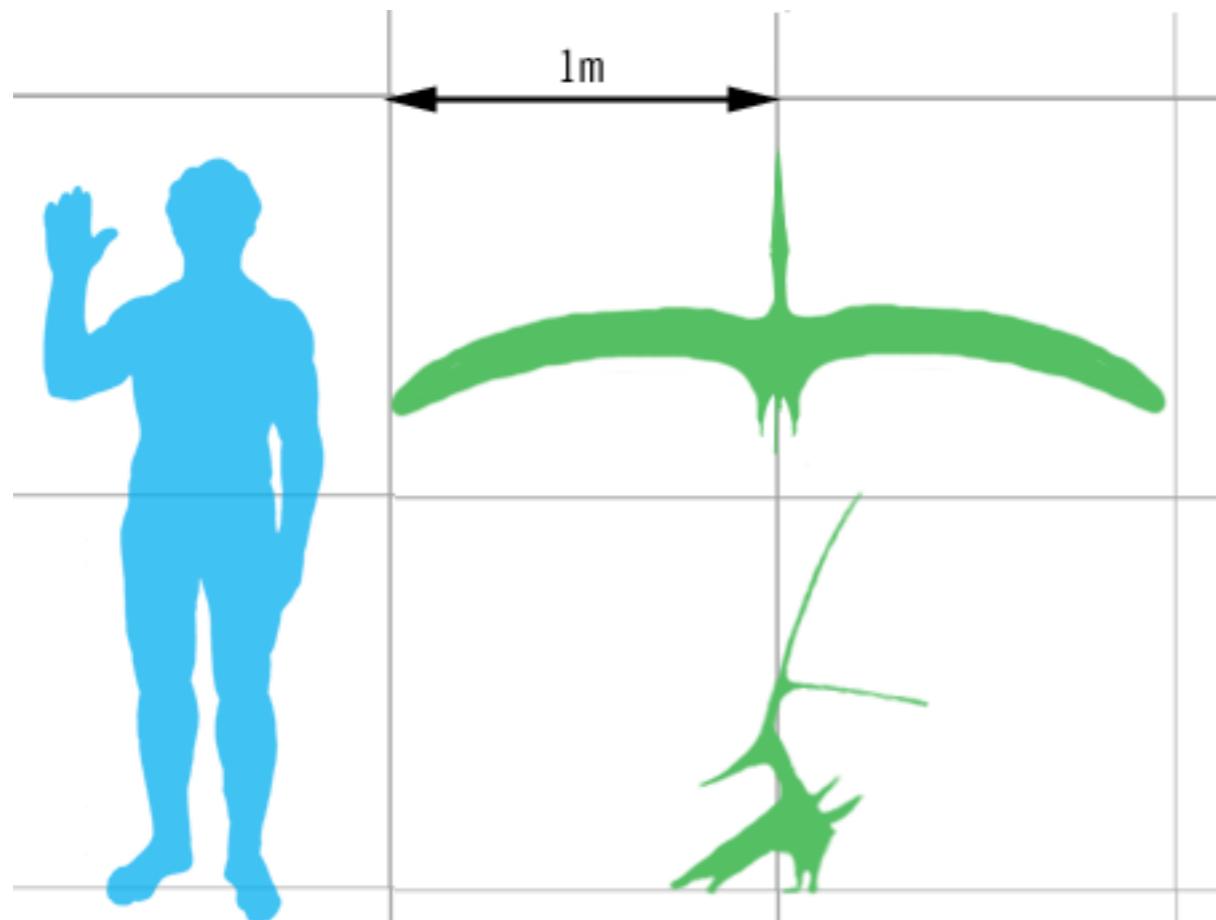
Keratinous



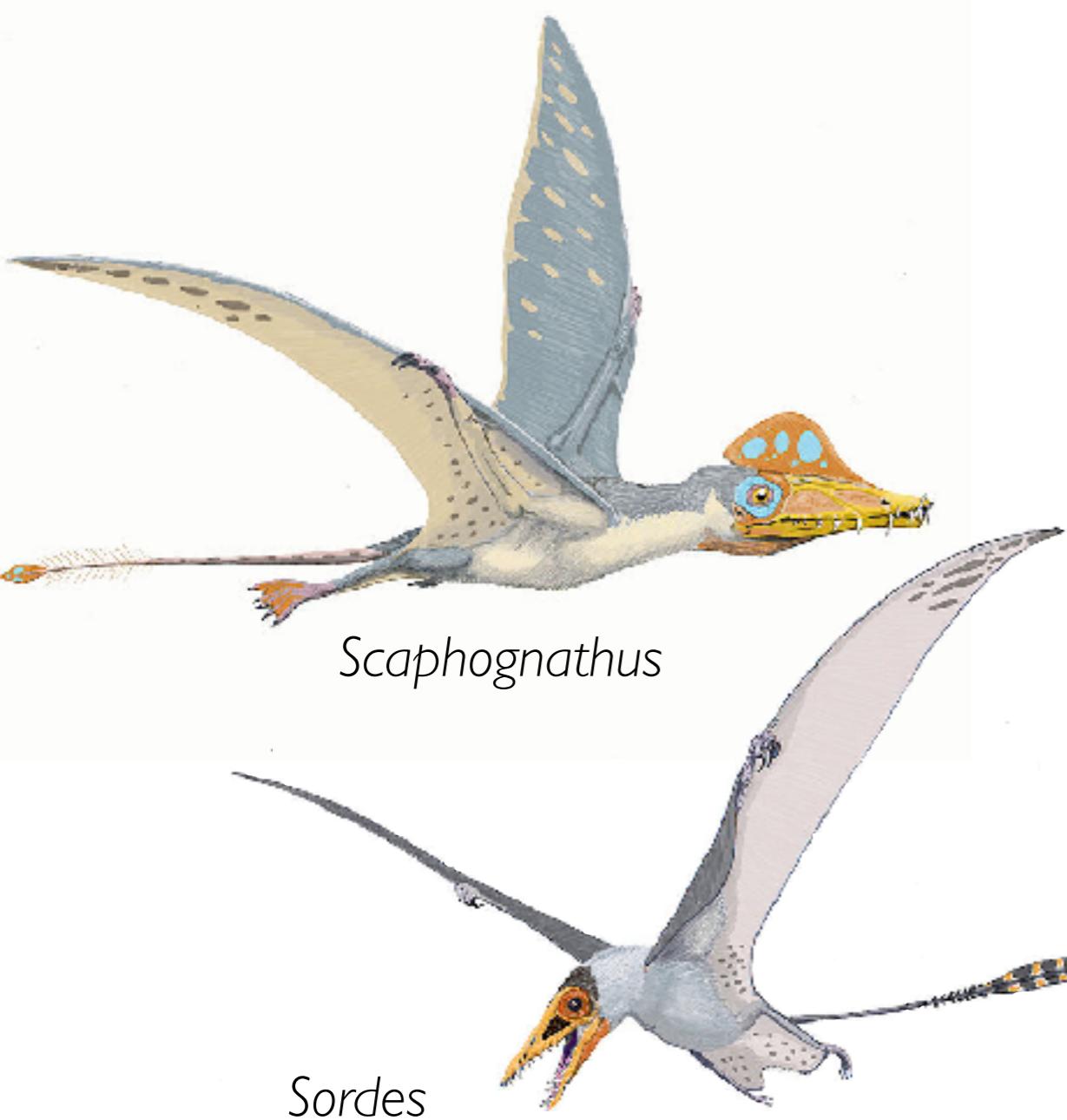
Pterosaur Traits: cranial crests

Nyctosaurus; late Cretaceous

Sometime, ridiculous things happen.



Pterosaur Traits: jaw diversity



Basal Pterosaurs (paraphyletic)
Late Triassic
Long teeth and nails
Most lacked bony crests

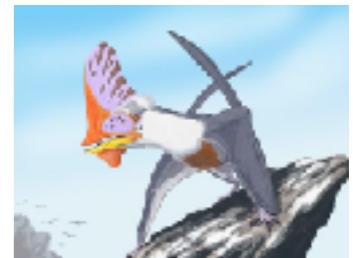


Dorygnathus



Campylorhynchoides

Ramphorynchids



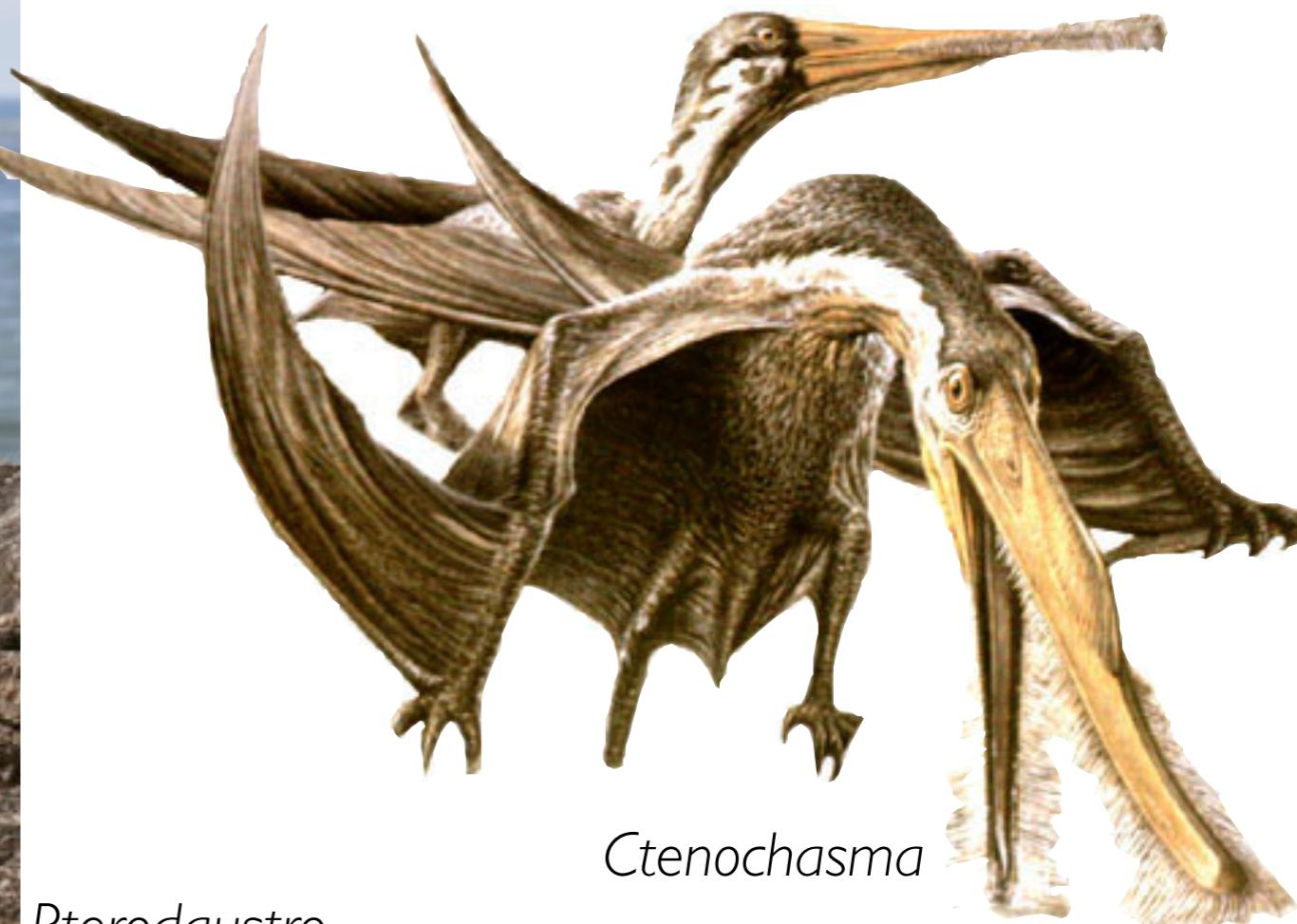


Dimorphodon





Pterodaustro



Ctenochasma



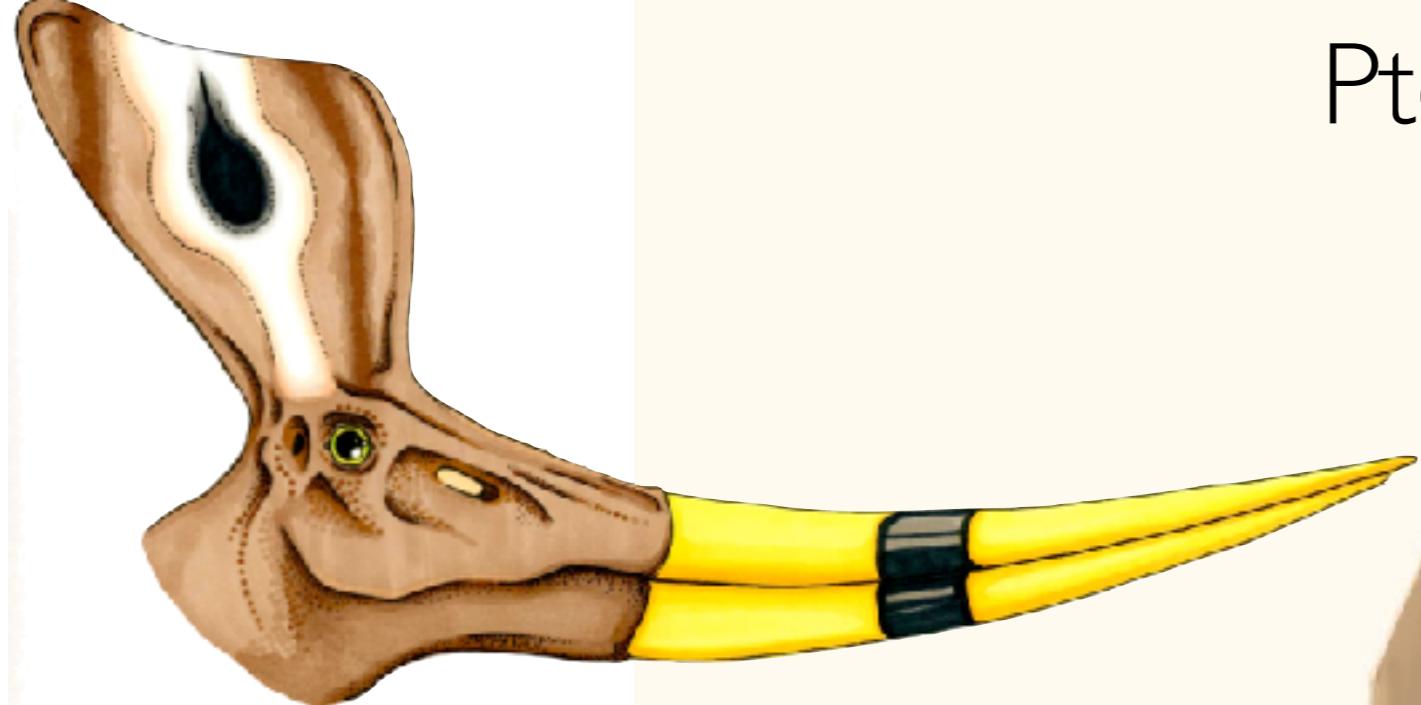
Ornithocheirus

Fisheaters, Filterers

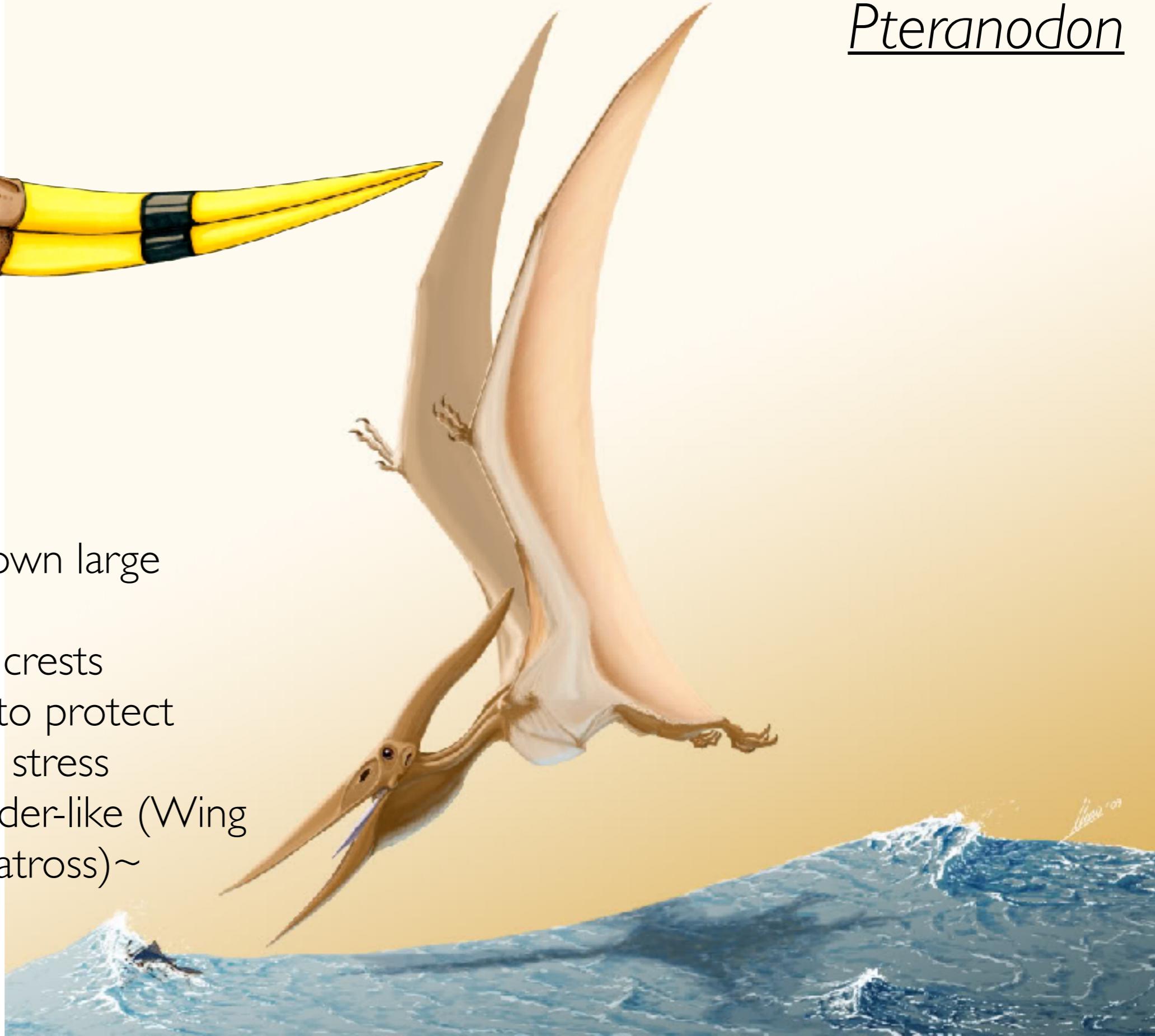


Pterosaur Traits: jaw diversity

Pteranodon



No teeth
Scoop-shaped bill
One of the best known large
Pterosaurs
Sexually Dimorphic crests
Heavily fused body to protect
against flight-related stress
Potentially more Glider-like (Wing
shape similar to Albatross)~
dynamic soaring
Piscivore







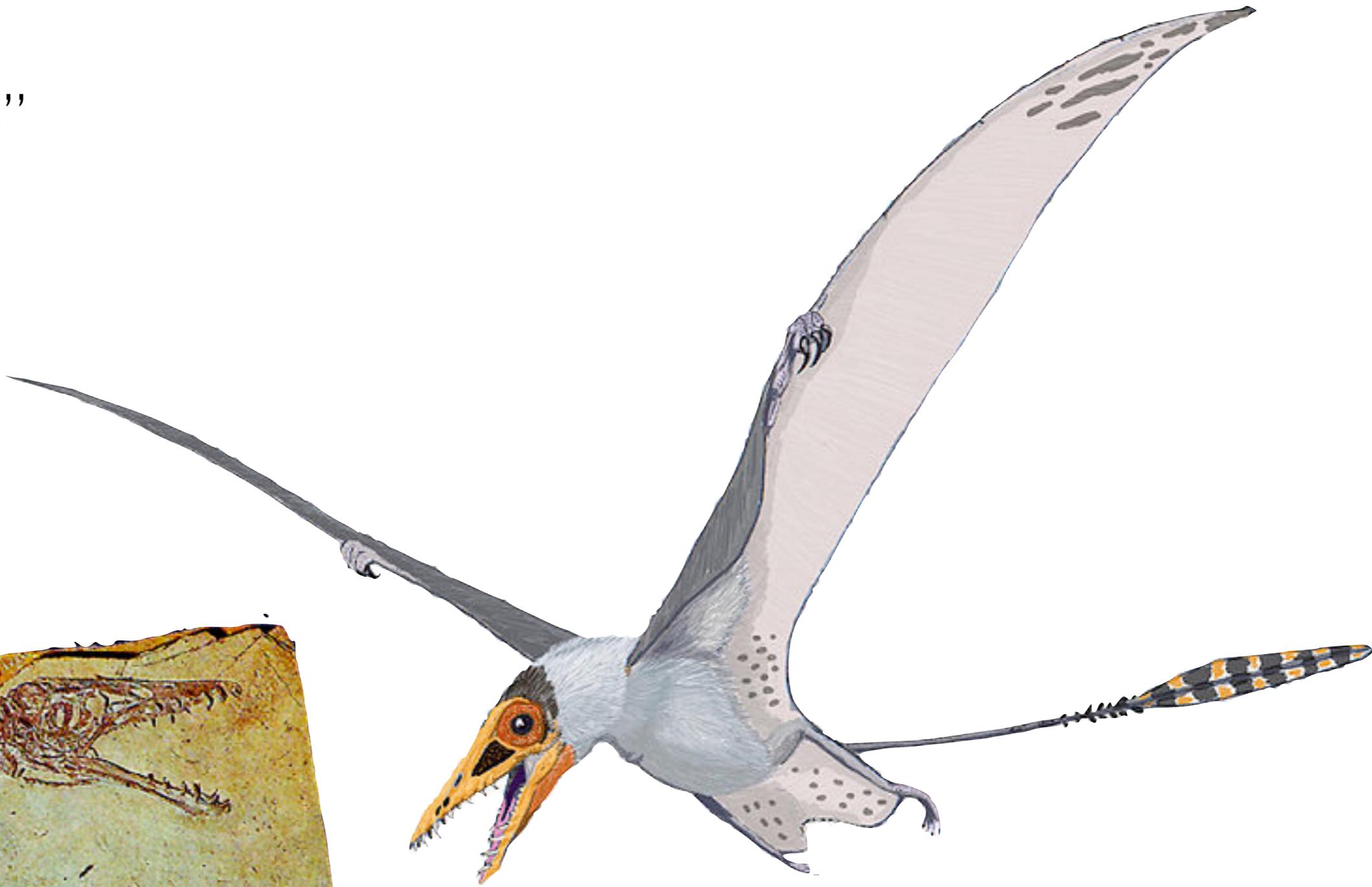


Pterosaur Traits: skin



Covered in hair-like filaments:
Pycnofibres
NOT HAIR
Similar in structure: convergent evolution
Very convincing evidence that these animals were **endothermic**

Sordes pilosus
“Hairy Demon”



Pterosaur Eggs

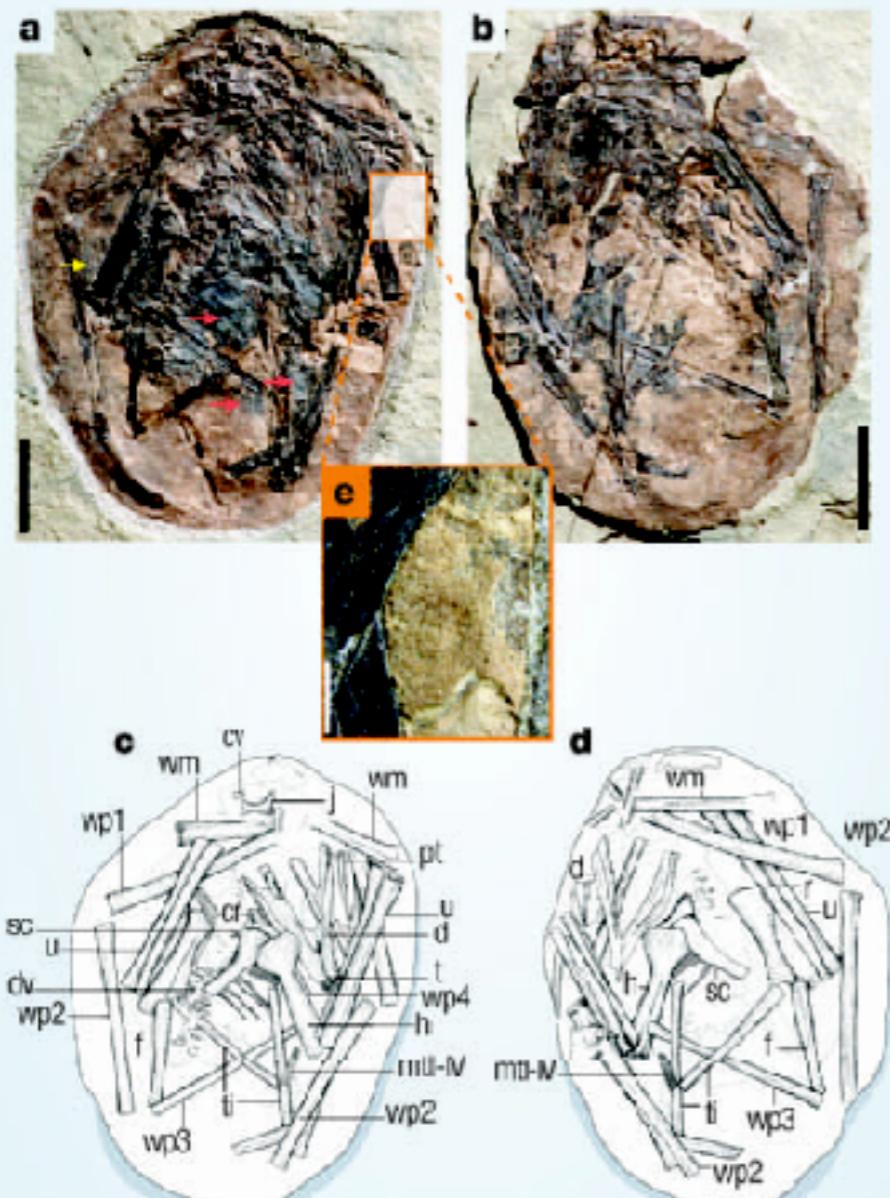


Figure 1 Pterosaur embryo inside an egg from the Early Cretaceous period from Liaoning, China (NPP V13/58). **a–d**, Photographs of part (**a**) and counterpart (**b**) of the fossil and their corresponding line drawings (**c**, **d**; not to scale). Red arrows indicate skin imprints and the yellow arrow indicates the fibres of the wing membrane. Scale bar, 10 mm. **e**, Close-up of the papilla-like ornamentation of the eggshell (corresponding to orange frame in **a**). Scale bar, 2 mm. Abbreviations in **c**, **d**: *cr*, coracoid; *cv*, cervical vertebra; *d*, dentary; *dv*, dorsal vertebra; *f*, femur; *h*, humerus; *j*, jugal; *mtl*, metatarsals I–IV; *pt*, ptcloid; *r*, radius; *sc*, scapula; *t*, tooth; *ti*, tibia; *u*, ulna; *wp1–4*, first to fourth phalanges of the wing digit; *wm*, wing metacarpal.

Thin, soft shelled eggs
No evidence of multiple laminar layers

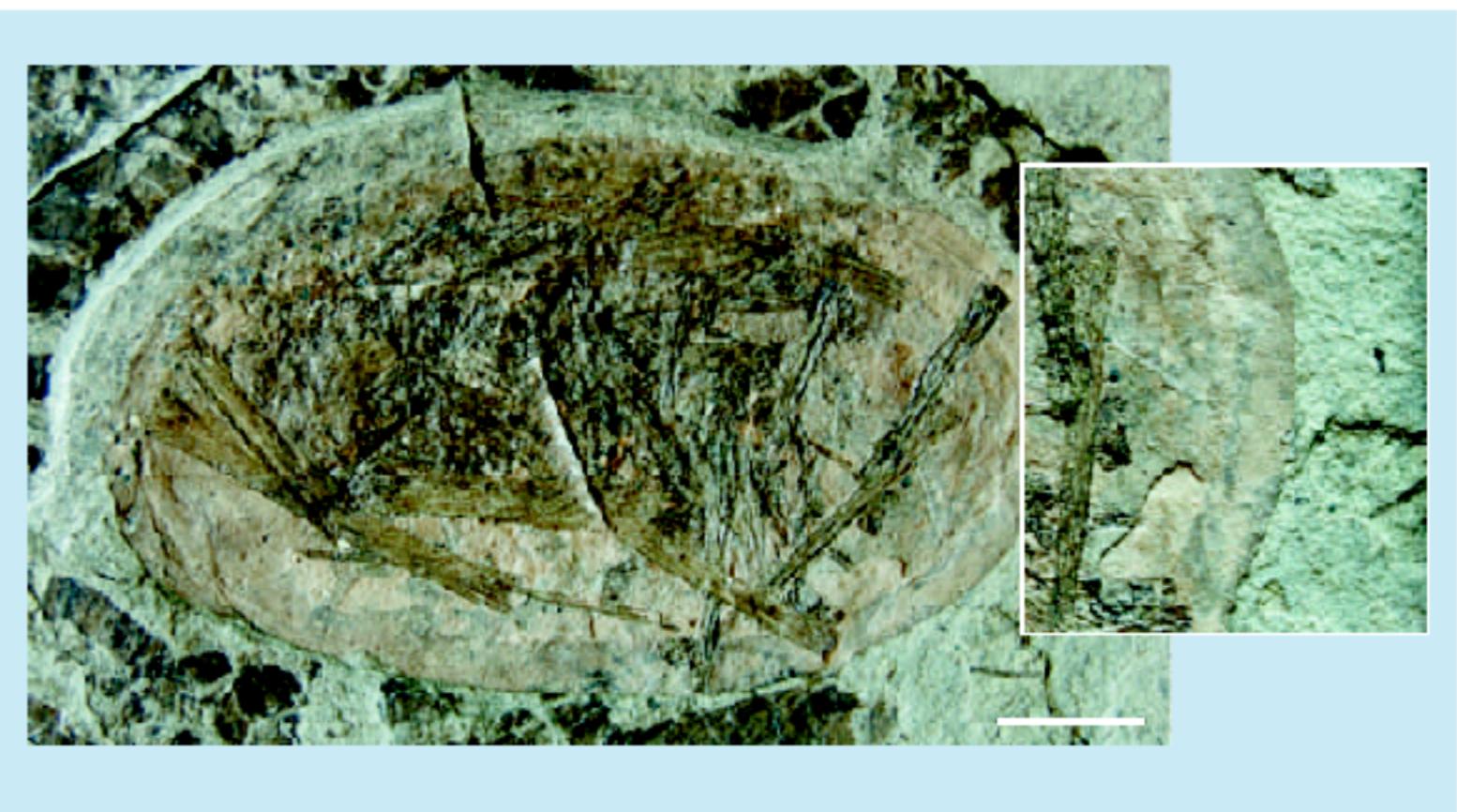
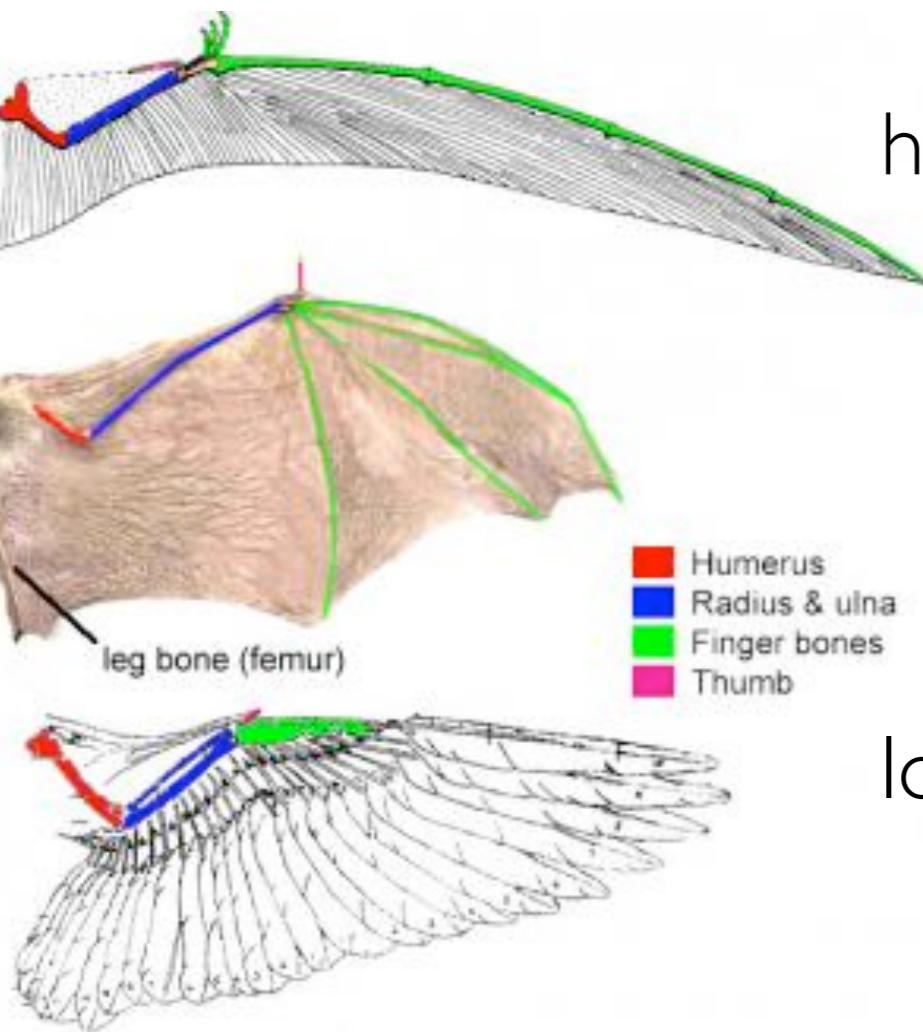


Figure 1 Early Cretaceous pterosaur egg and embryo (JZMP 03/03/2) from the Yixian Formation of Liaoning, China. Scale bar, 1 cm. Inset, magnification of egg boundary (130%) showing the thin, soft shell and no evidence of lamination structures. For composite drawing of the specimen, see supplementary information.

Pterosaur Flight



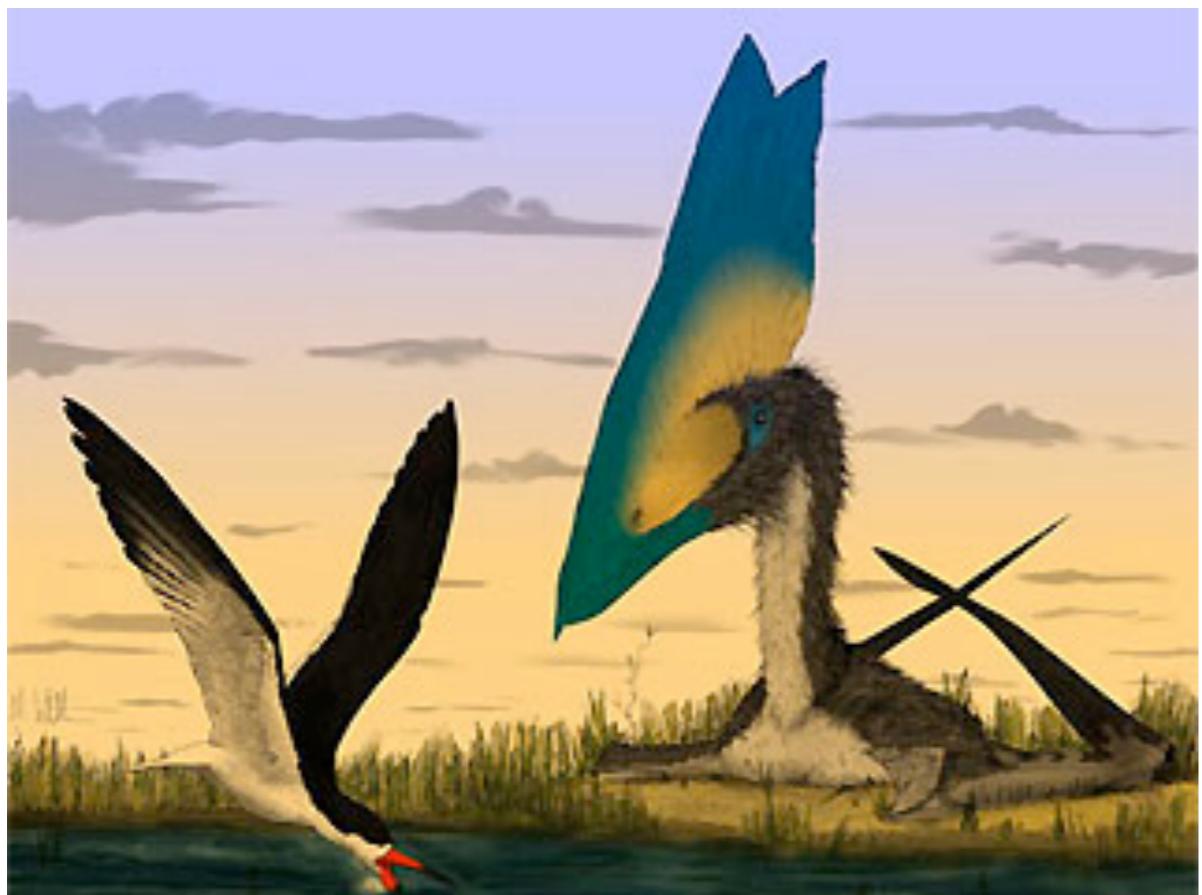


high aspect ratio
(long, slender)

low aspect ratio
(short, squat)



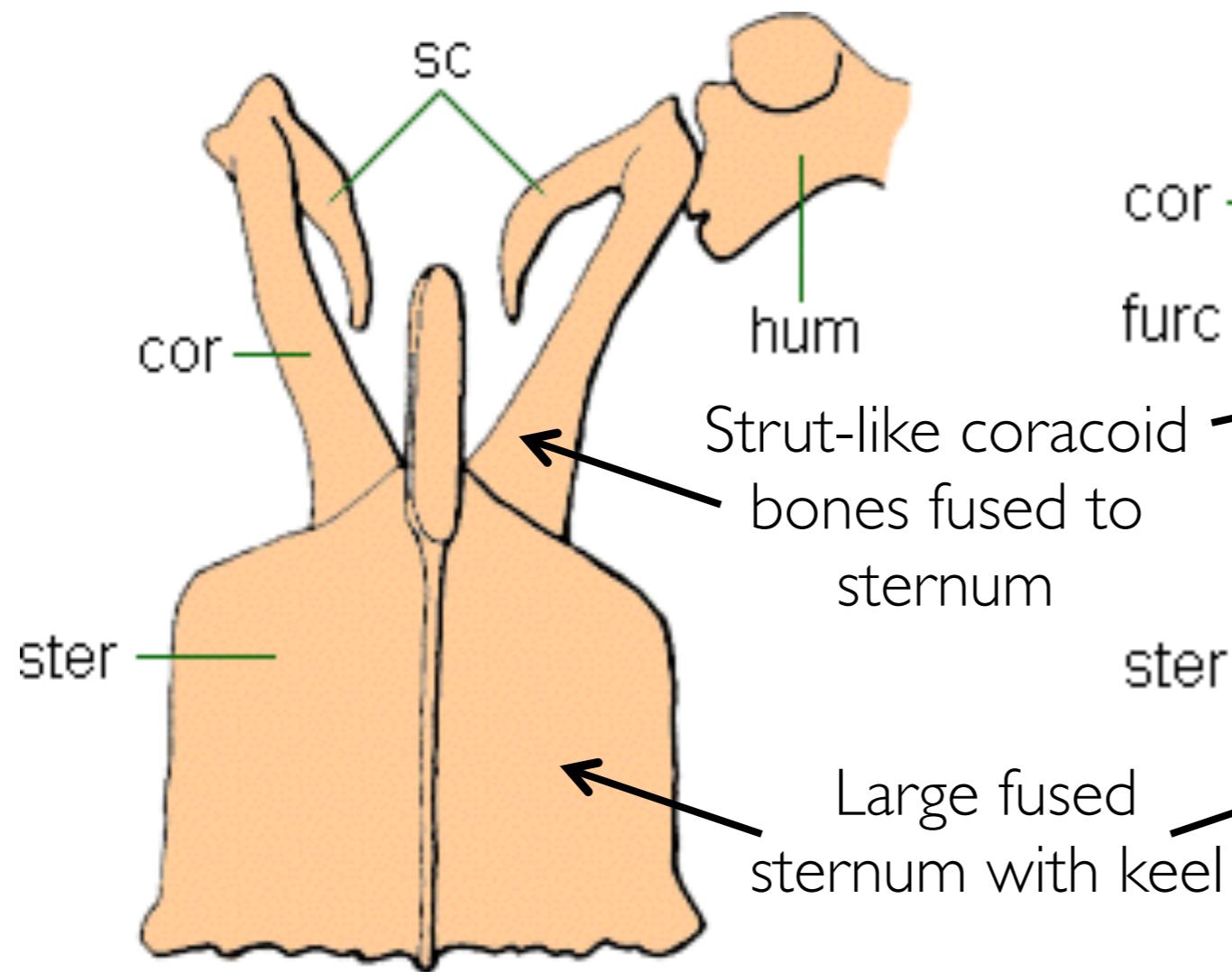
Convergent Flight Adaptations in Pterosaurs



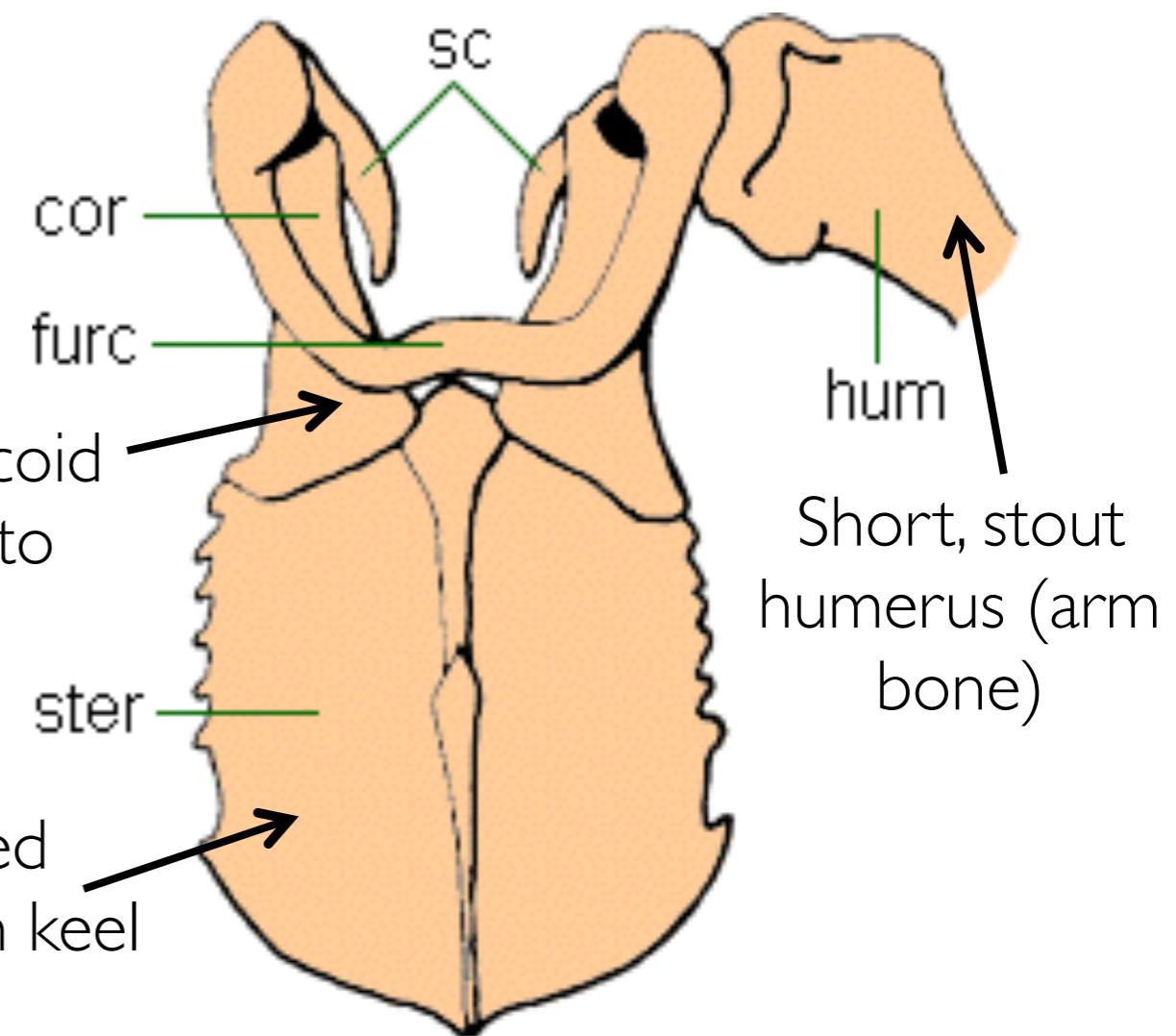
Pectoral Girdle Similarities

Pterosaurs independently evolved a pectoral girdle for supporting flight muscles

Pterosaur pectoral girdle

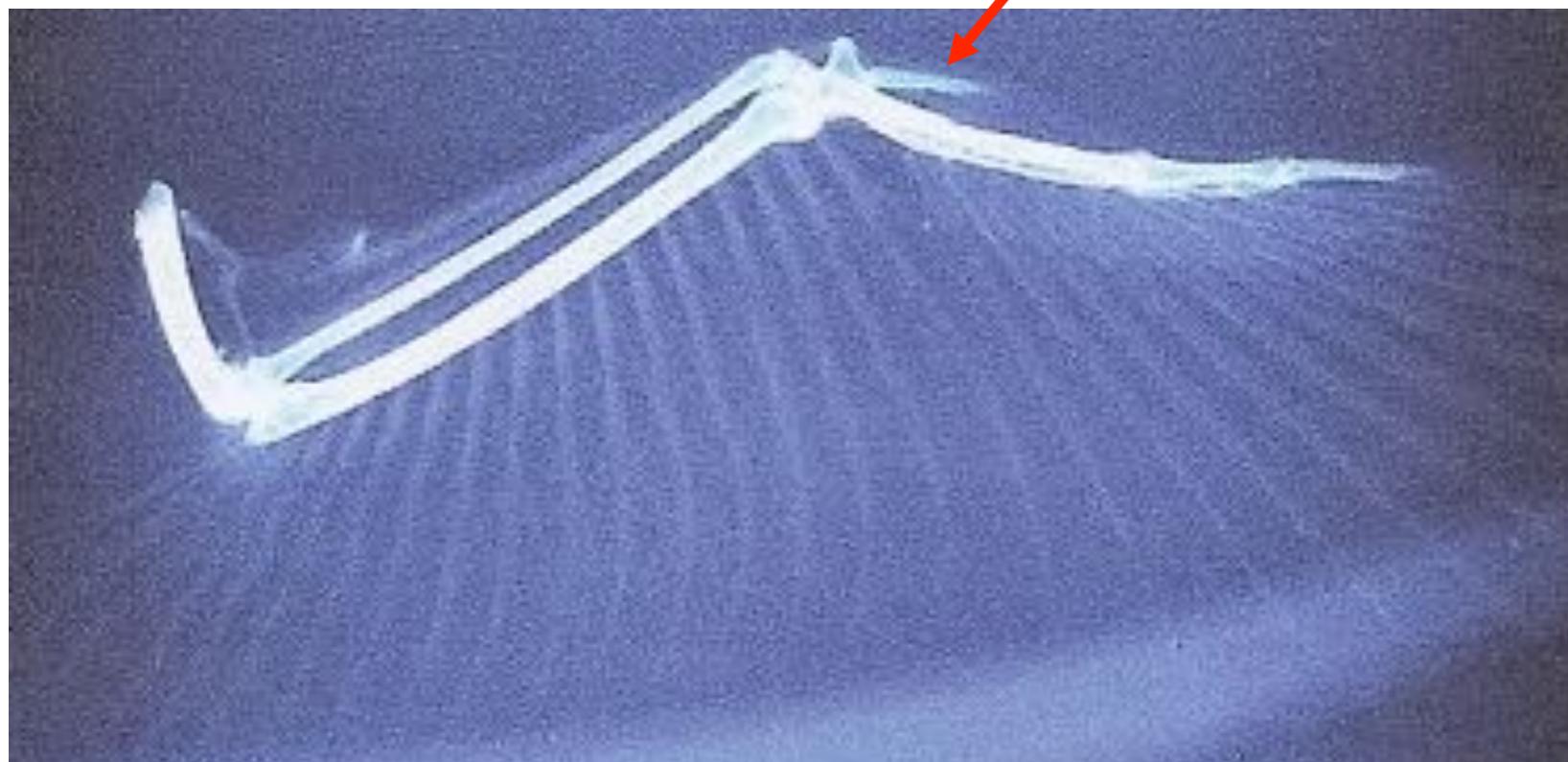
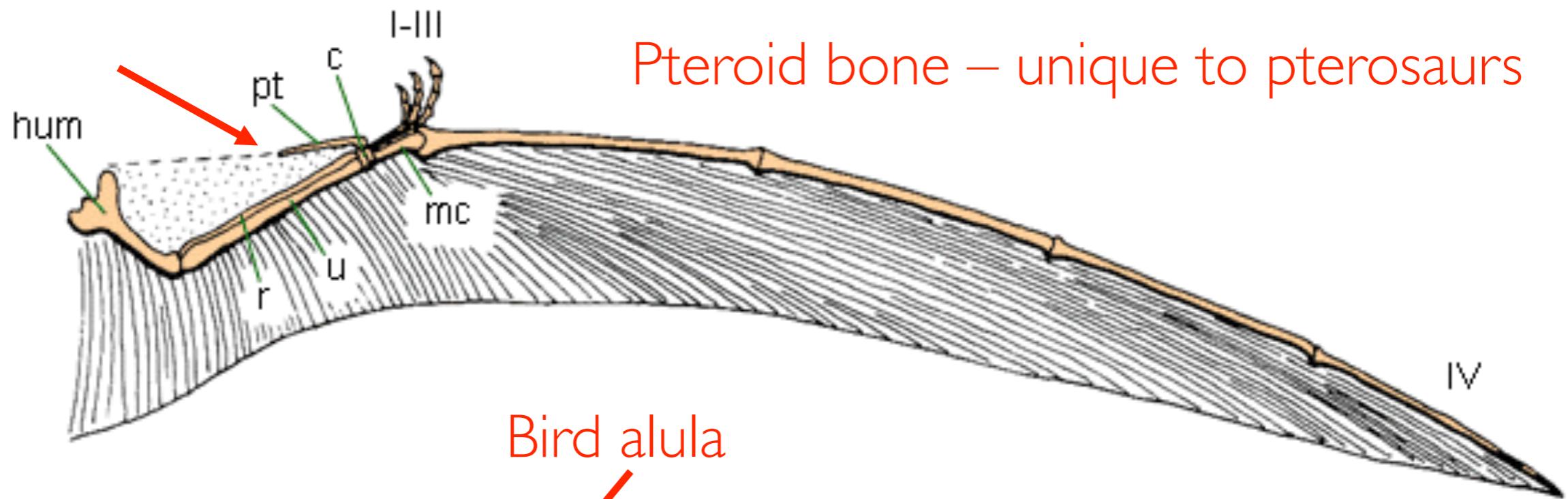


Avian pectoral girdle



No feathers – instead use skin membrane stretched across hand

Wing surface primarily supported by extended finger digit IV



Bird wing: feathers

Wing surface primarily supported by ulna, wrist



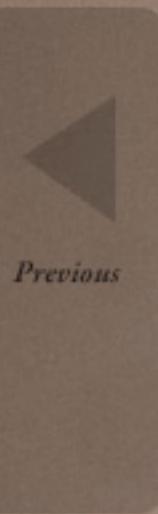
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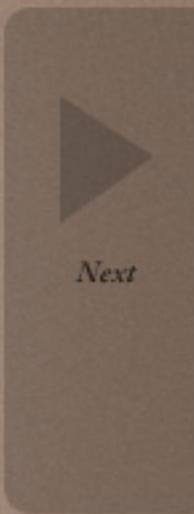
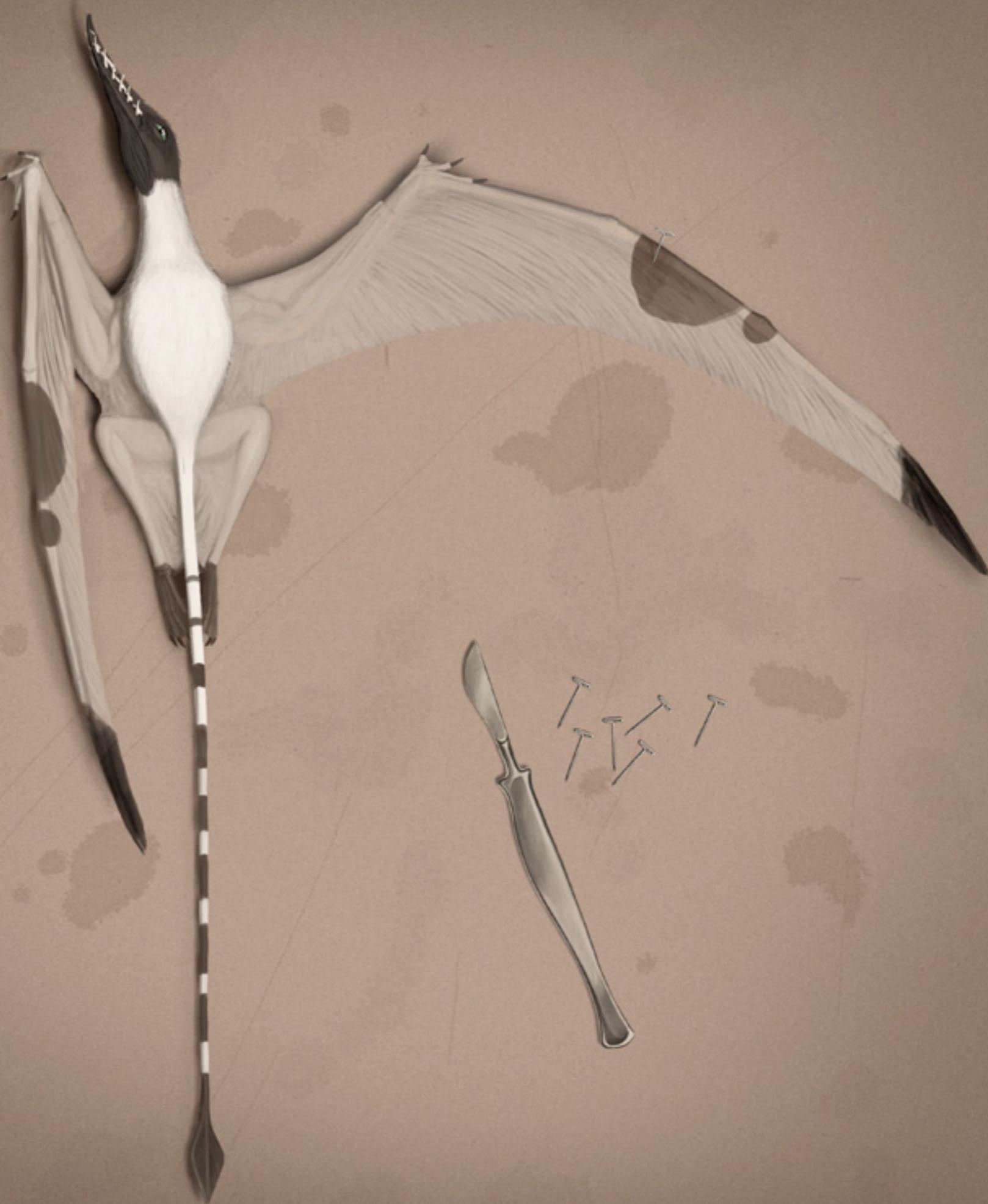
Dissecting
Rhamphorhynchus



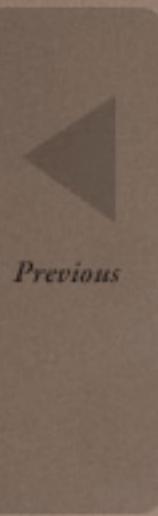
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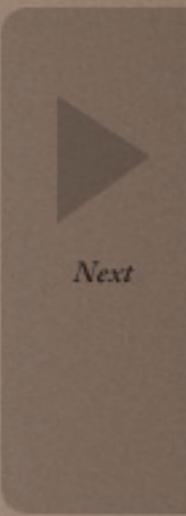
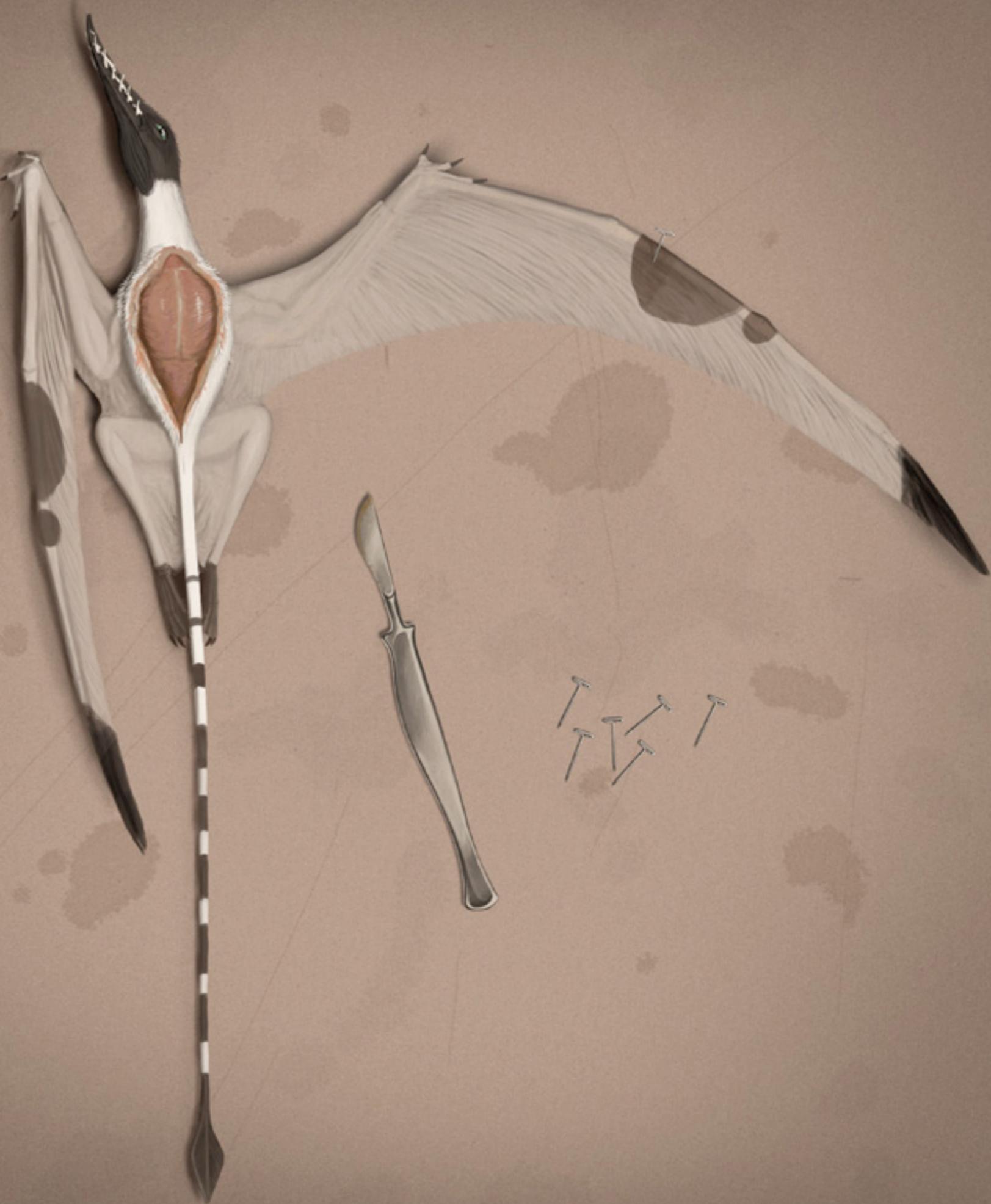
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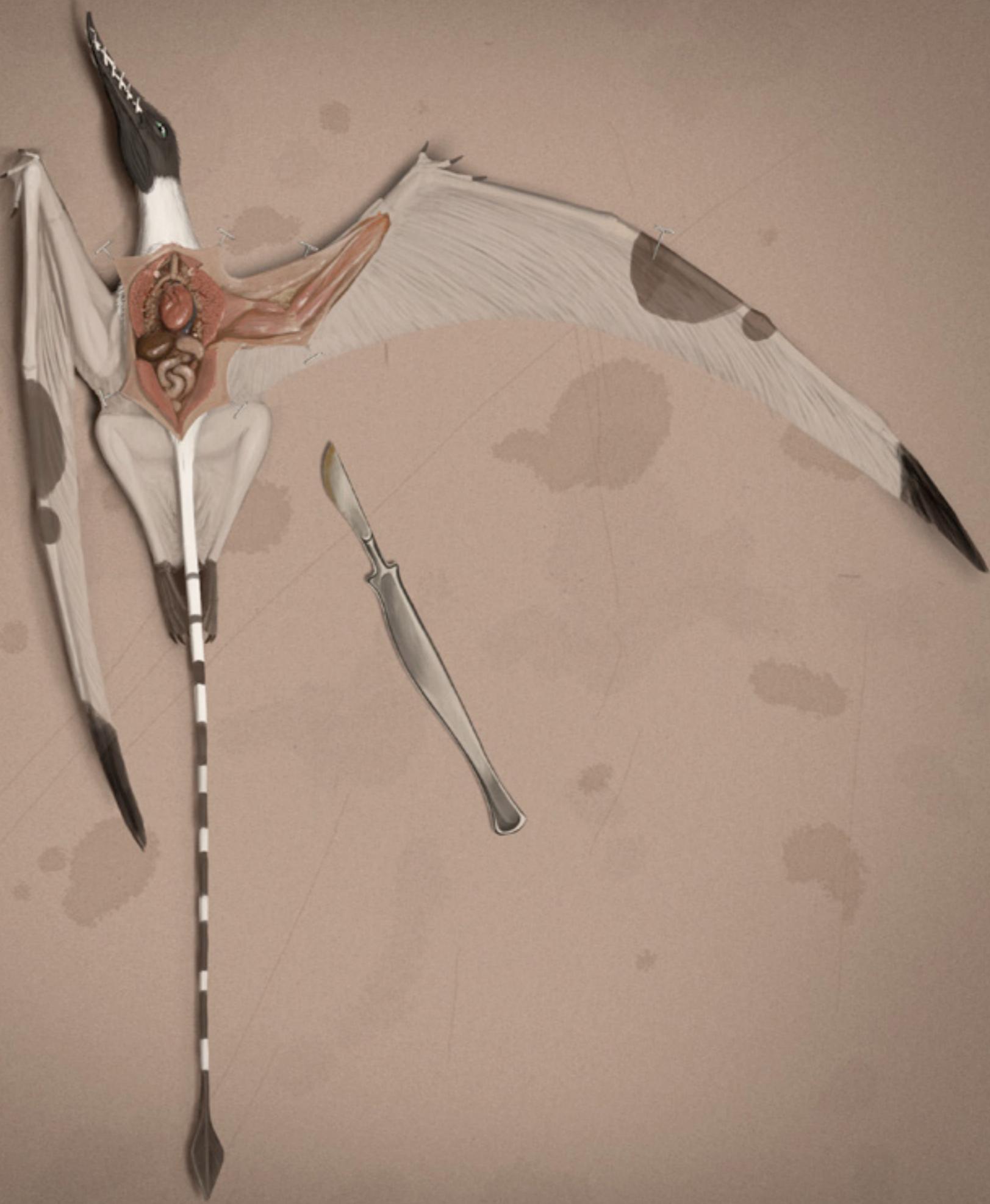
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Unique Flight Adaptations in Pterosaurs

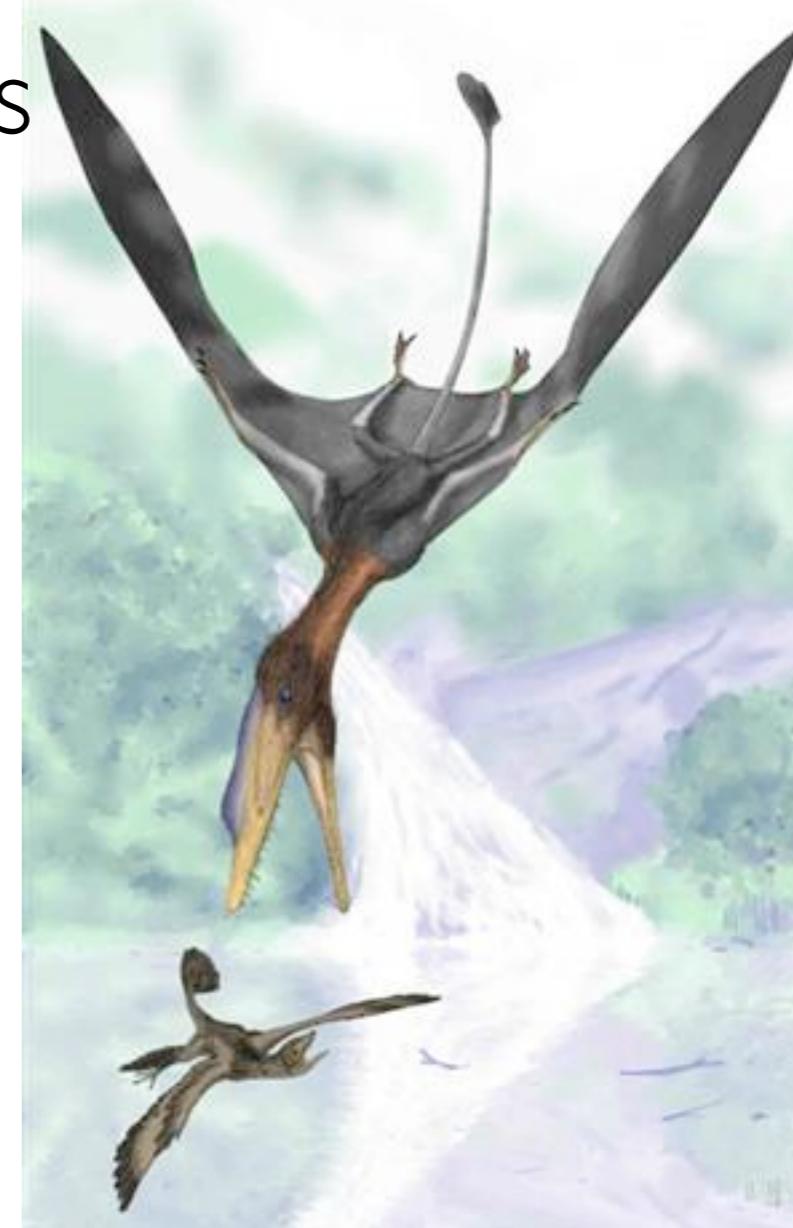
Wing support

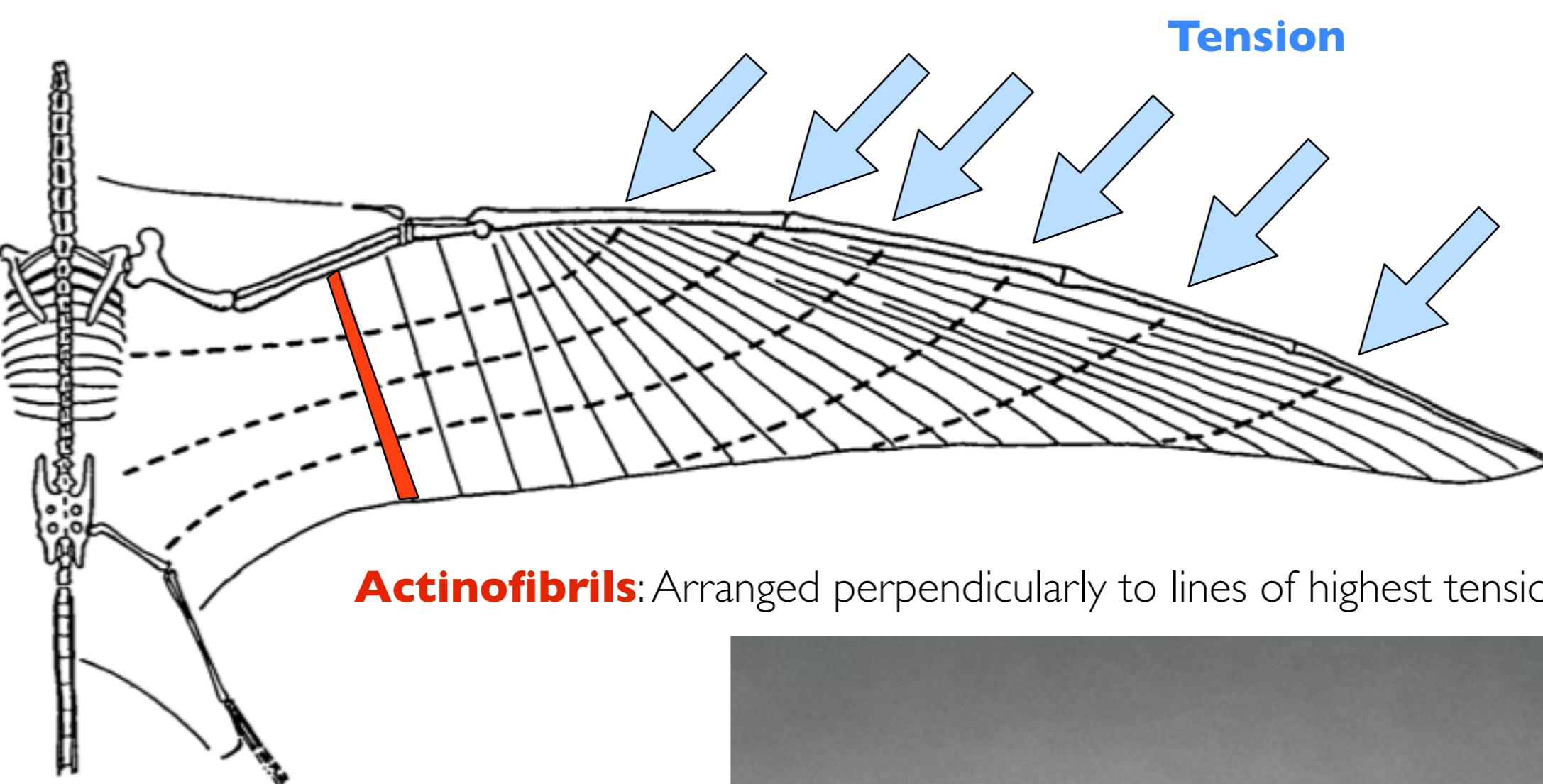
Outer wing supported by **Actinofibrils**

3 distinct layers of criss-crossed fibers

Keratin? Elastin? Unknown.

Oxygenated by looping blood vessels



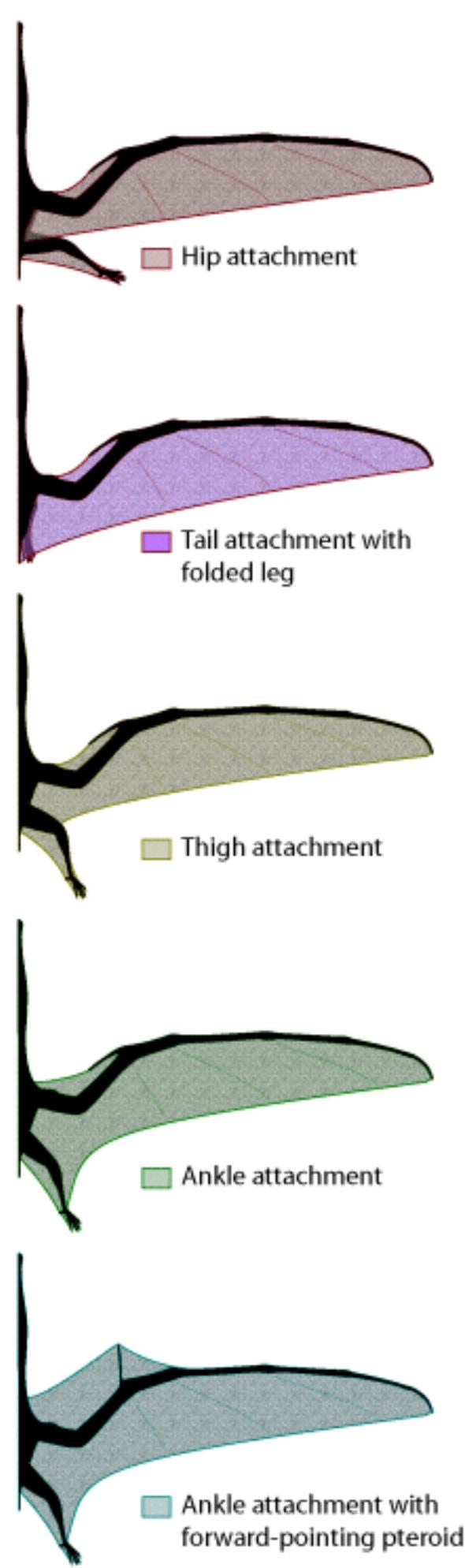


Actinofibrils: Arranged perpendicularly to lines of highest tension in wing

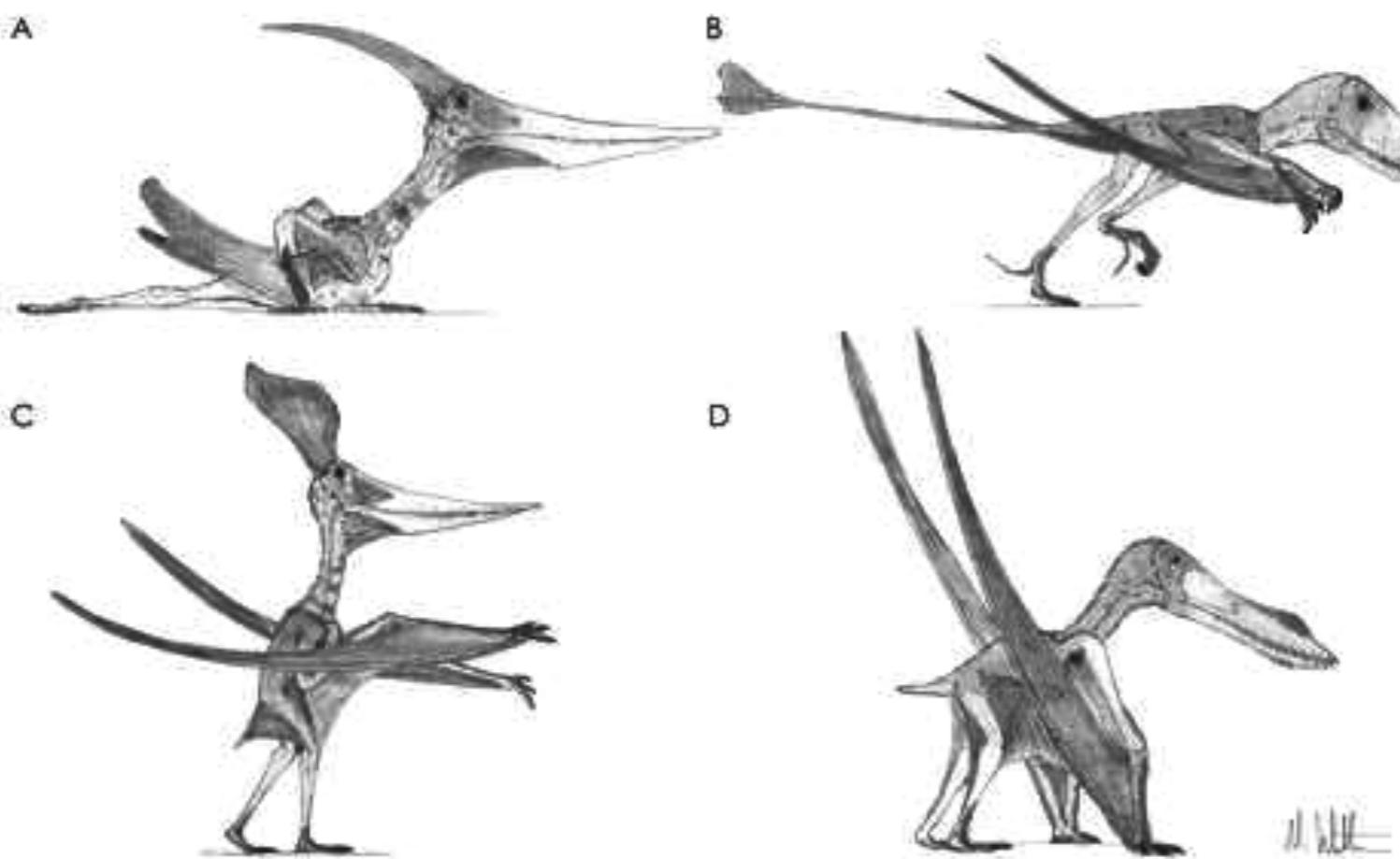


Alternative Wing Structures

Wing structure highly variable in modern animals
Almost certainly was variable among Pterosaurs
There is likely no 'One right answer' here



Pterosaur Walking



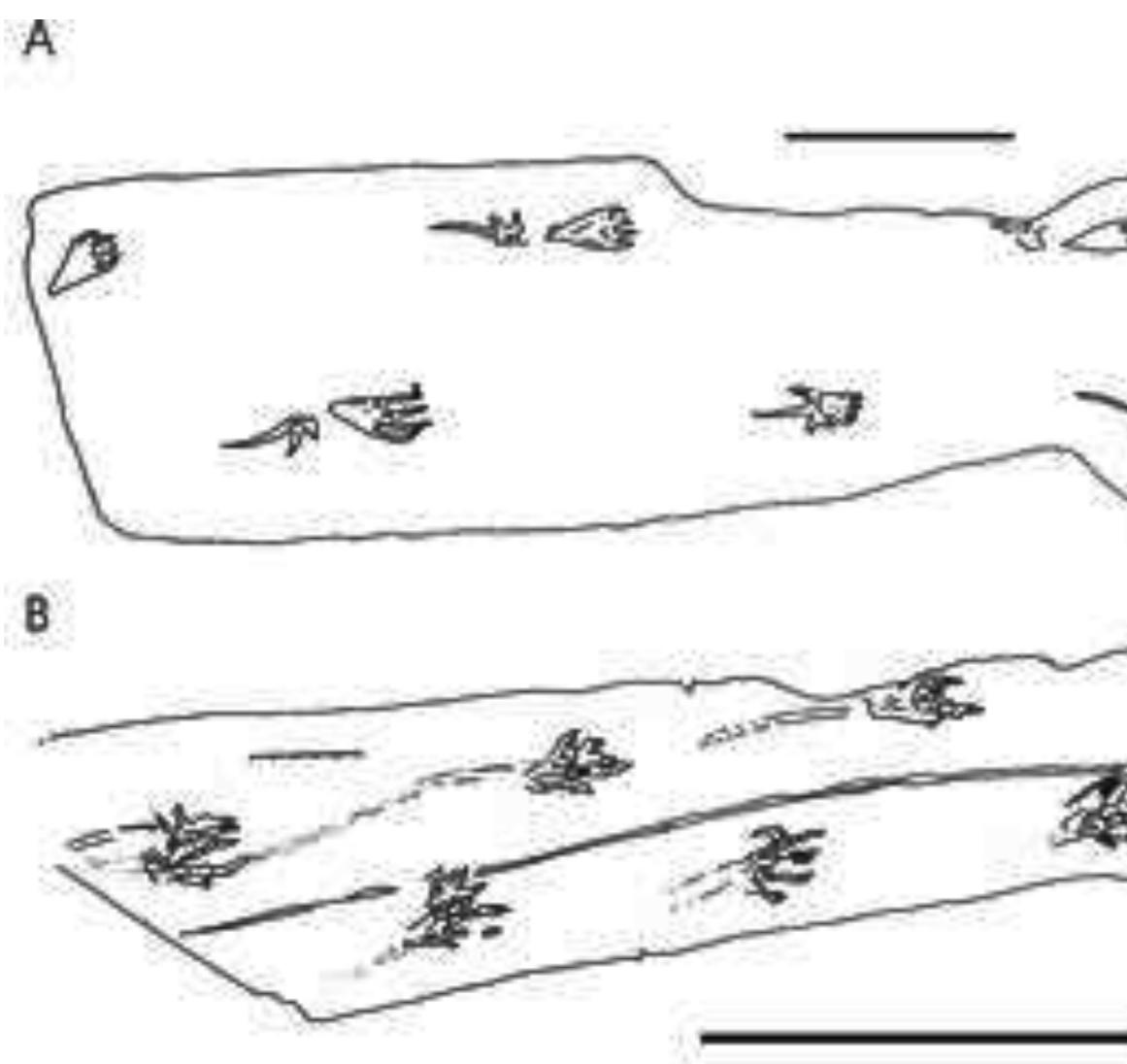
An evolving concept...

- A) 1970s: Belly dragging
- B) 1980s: Bipedality
- C) 1990: Semi-erect
- D) 1990s: Sprawling

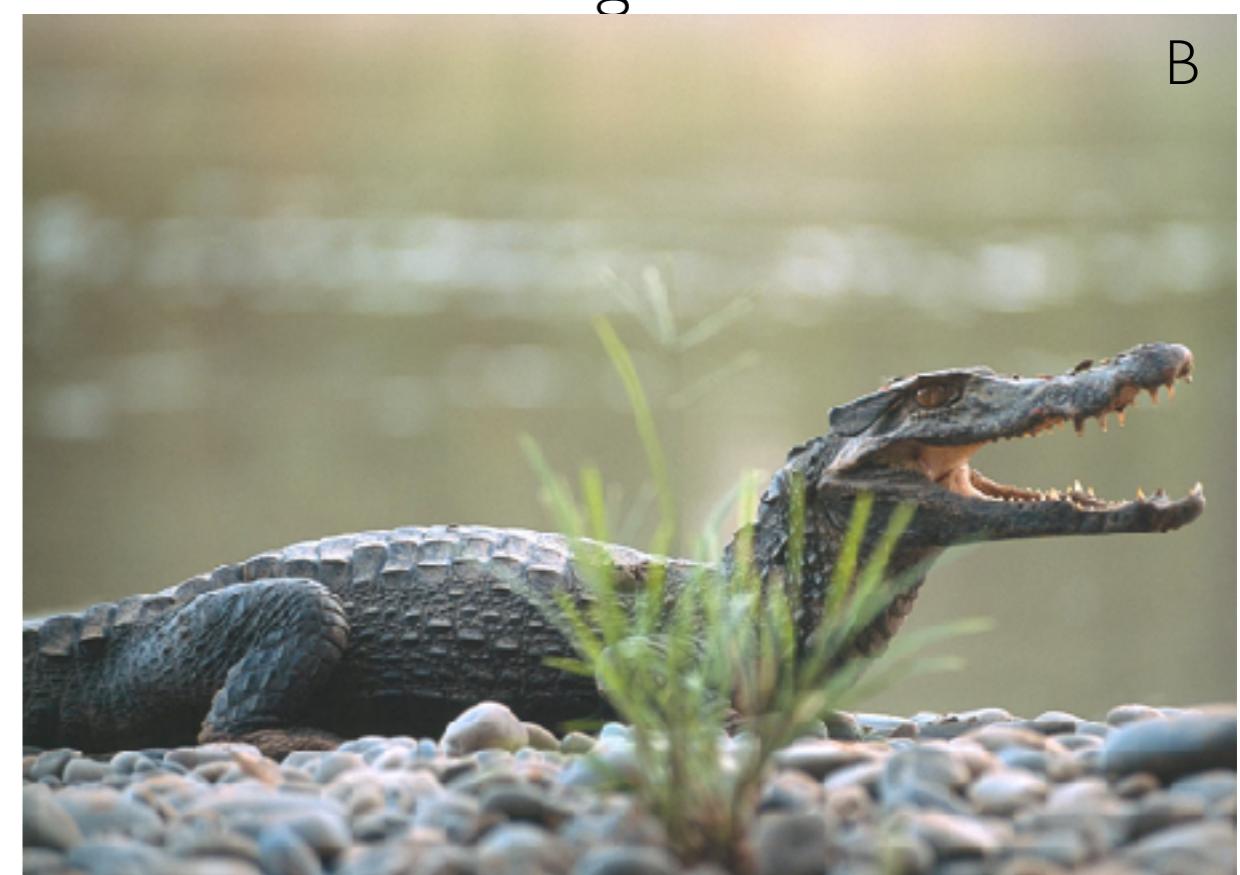
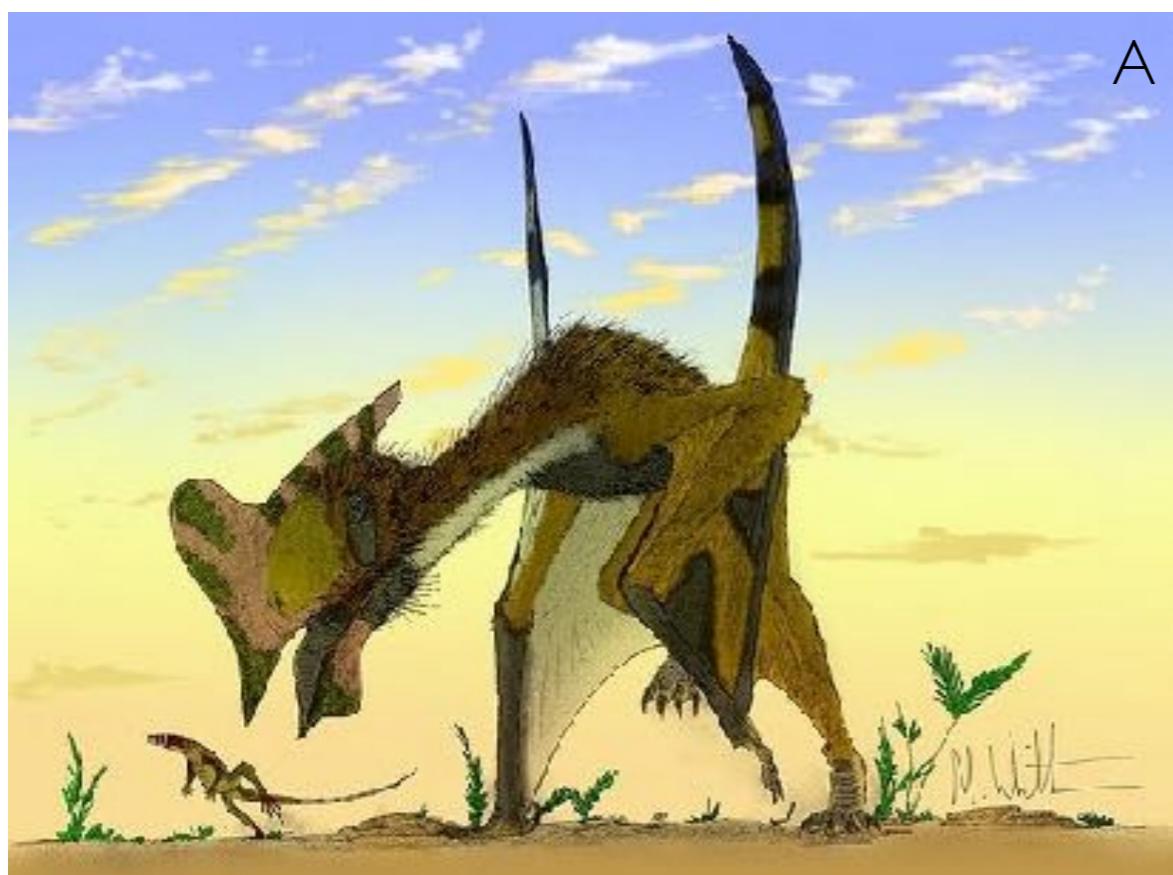


Still a source of contention!

Pterosaur Walking



Top: Pteraichnus
Bottom: Running Caiman





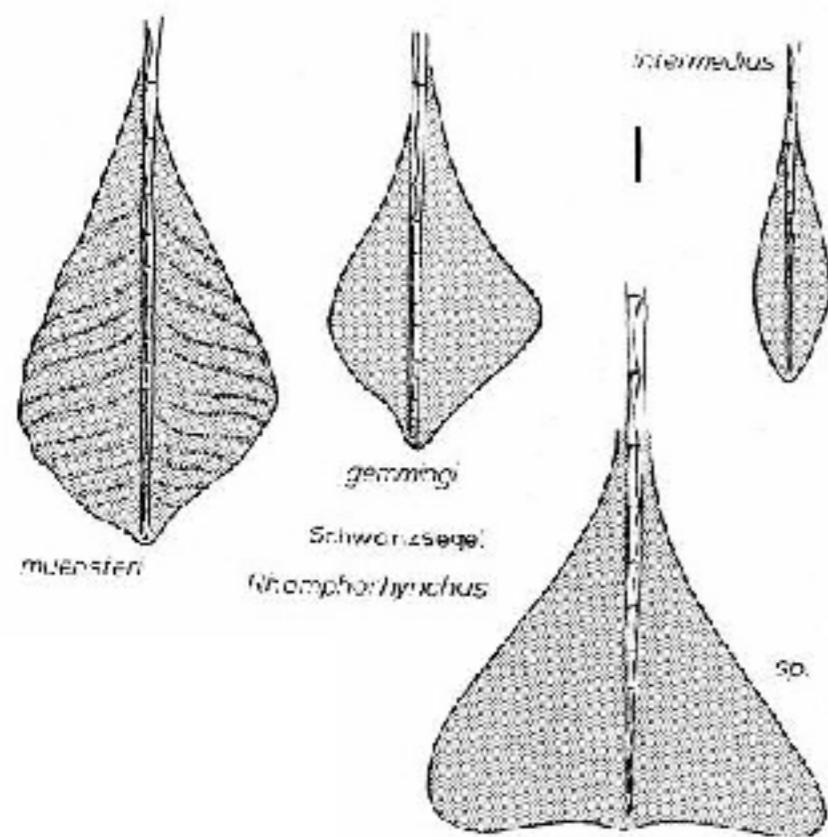
www.muvhaus.com



Tail Vanes



Present among early Pterosaurs; particularly *Ramphorynchus*
Much reduced among derived Pterosaurs
Probably a stabilizing feature
More diamond-shaped among older animals



Unique Flight Adaptations in Pterosaurs



Laser Beam eyes

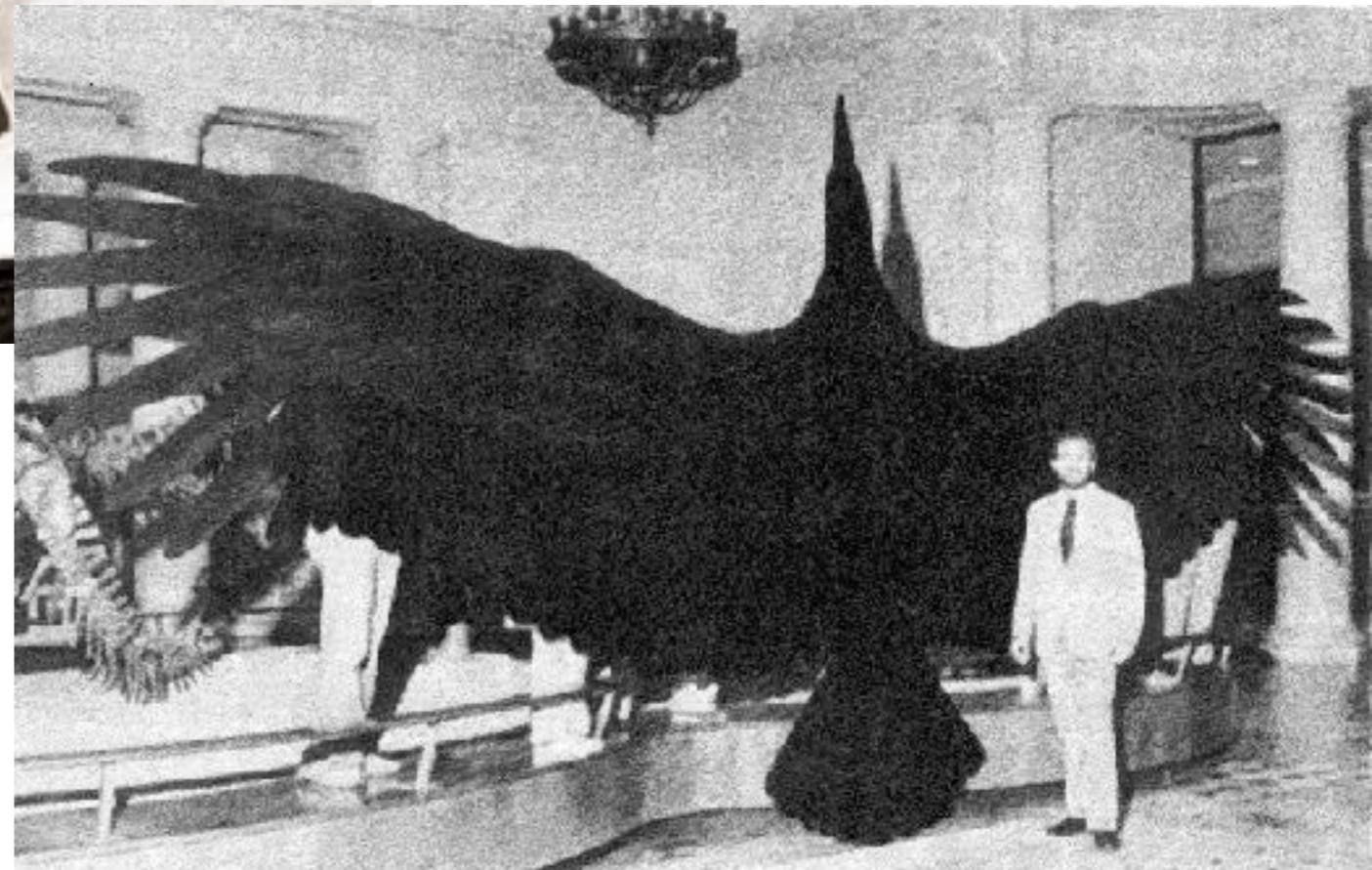
Convergently evolved in Kryptonian humanoids



Giant Flying Animals



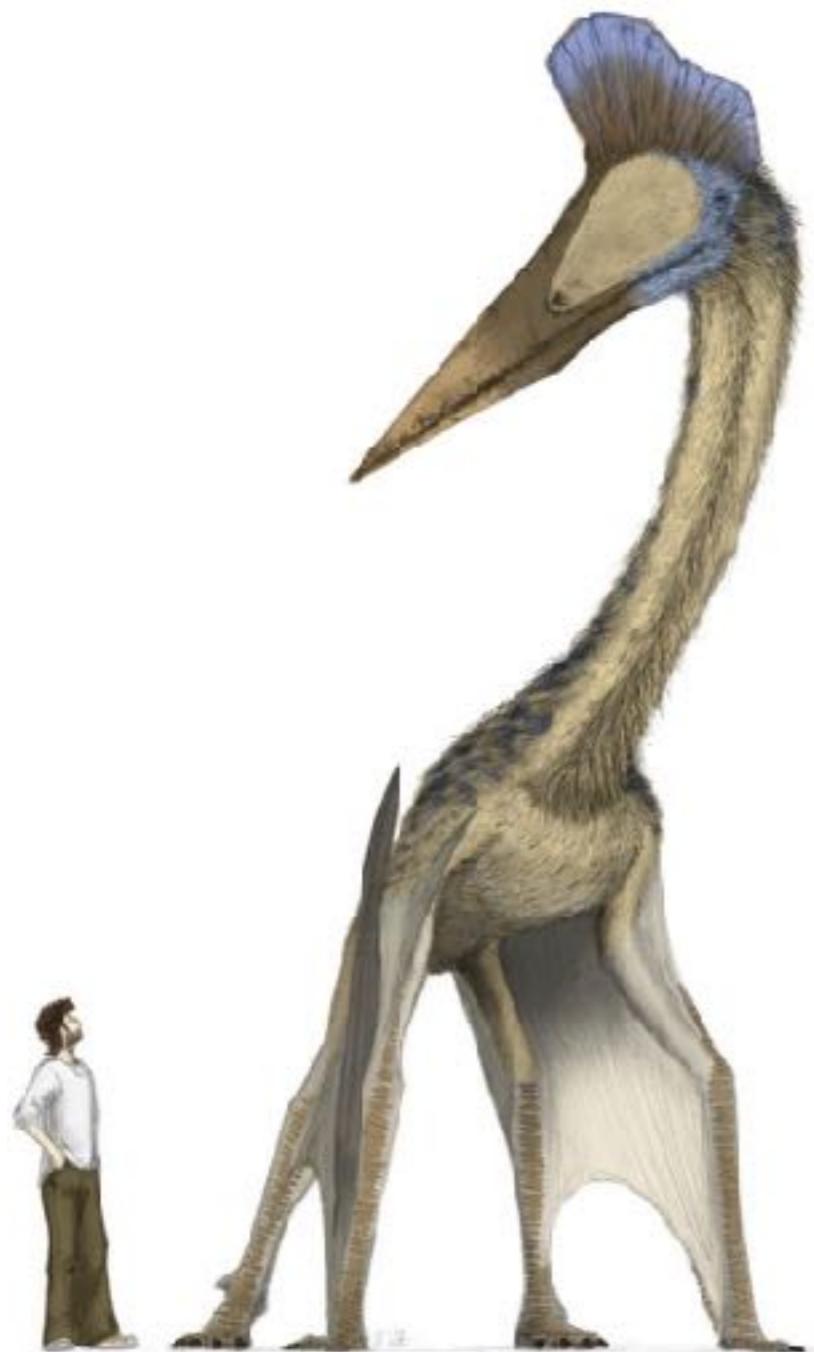
Largest pterosaur (*Quetzalcoatlus*, from the latest Cretaceous) had a 12 m wingspan and weighed 100 kg



Largest bird (*Argentavis*, Miocene) had 7 m wingspan and weighed 80 kg

Giant Pterosaurs

Largest pterosaurs were probably excellent gliders but would have had difficult reaching takeoff velocity



Pterosaur documentary 10:13



