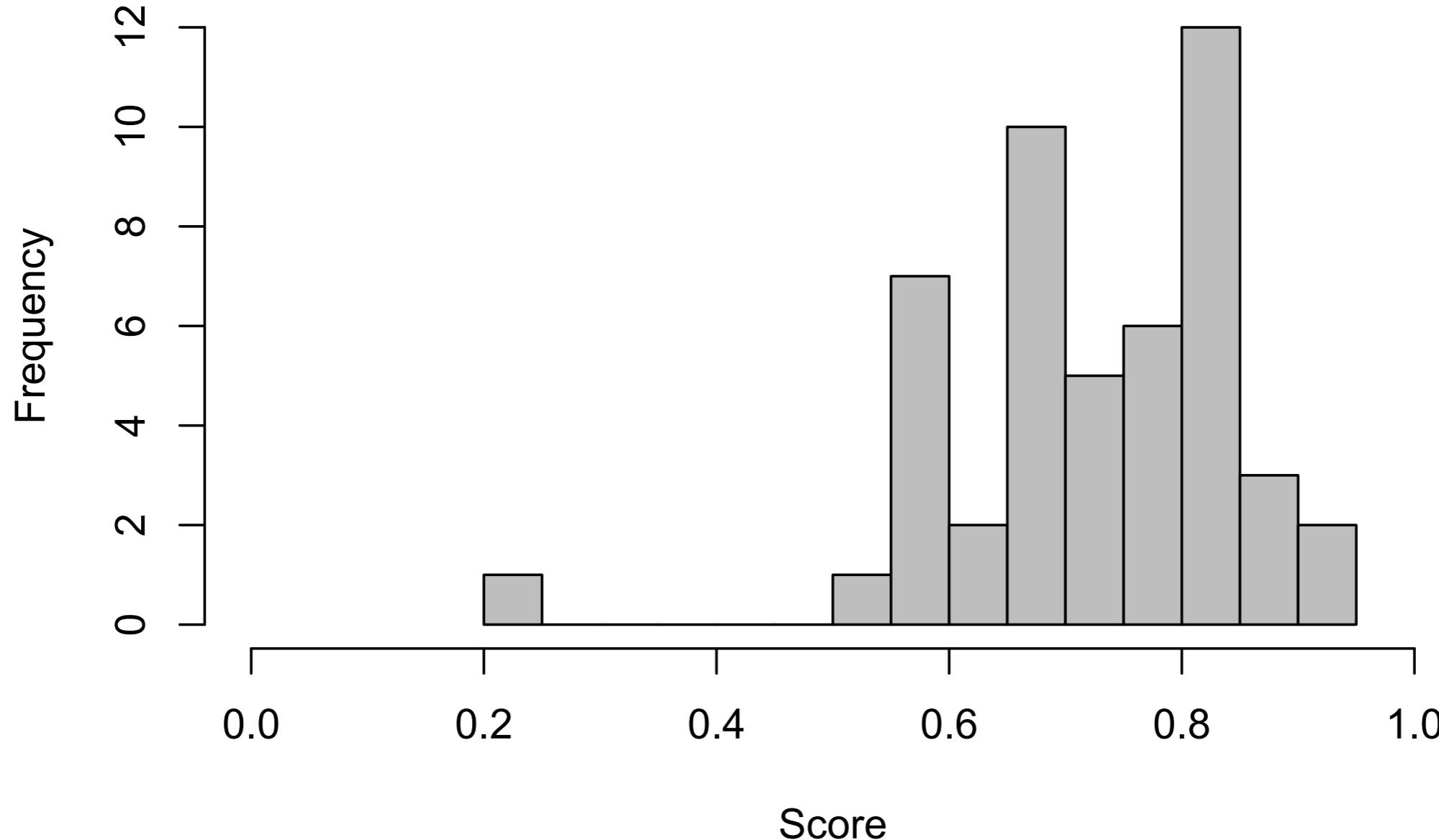


Histogram of x



Mean: 72%

Flying Reptiles of the Mesozoic

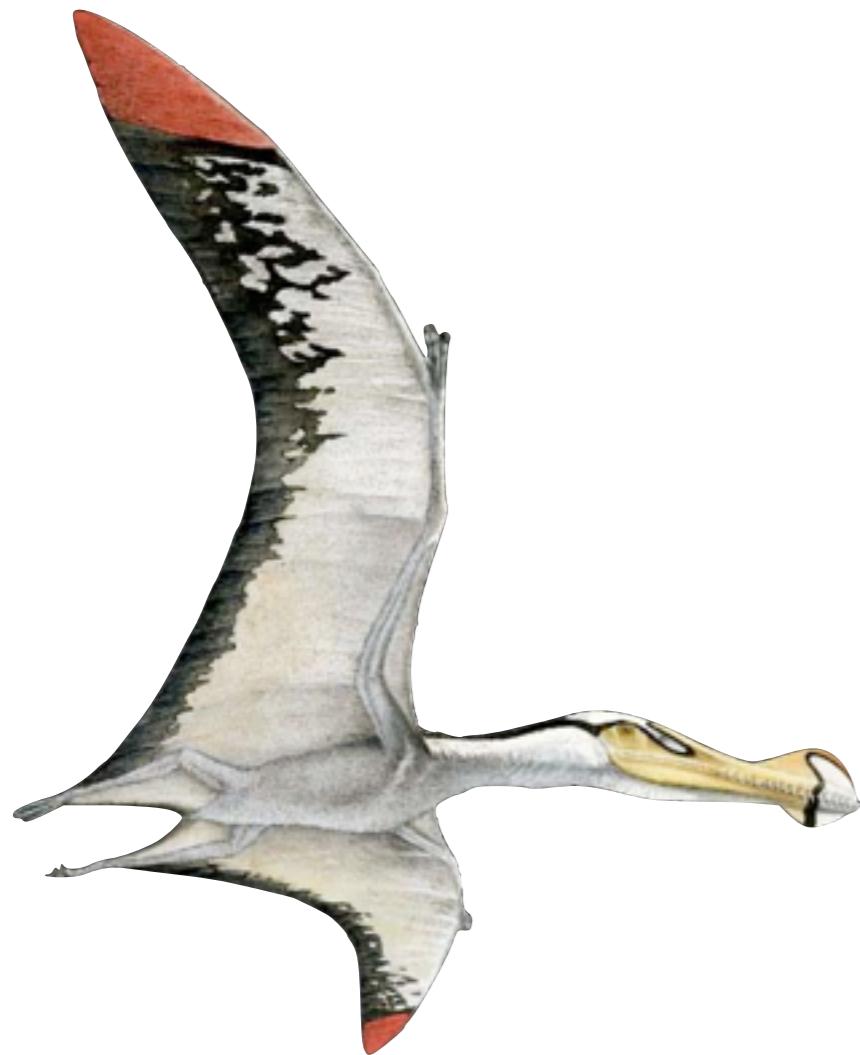


(c) Mark Witton 2009

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
- Flying pterosaur reptiles are not related to birds but display convergent evolution of many flight adaptations

Pterosauria



Earliest vertebrates known to evolve
powered flight!

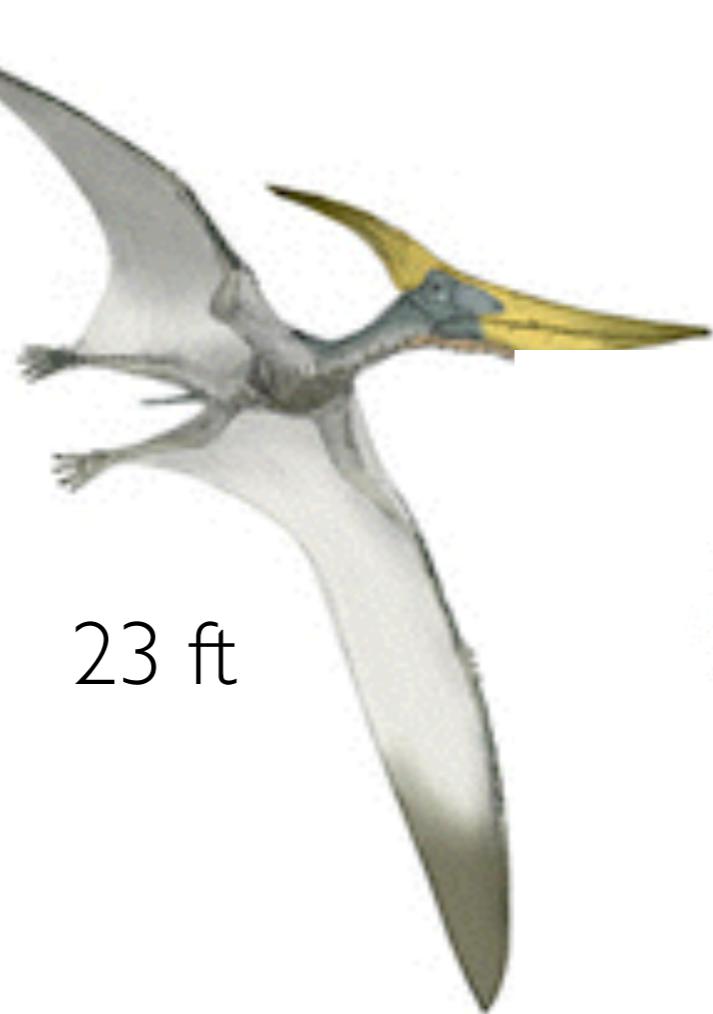
Pterosauria



10 in



23 ft



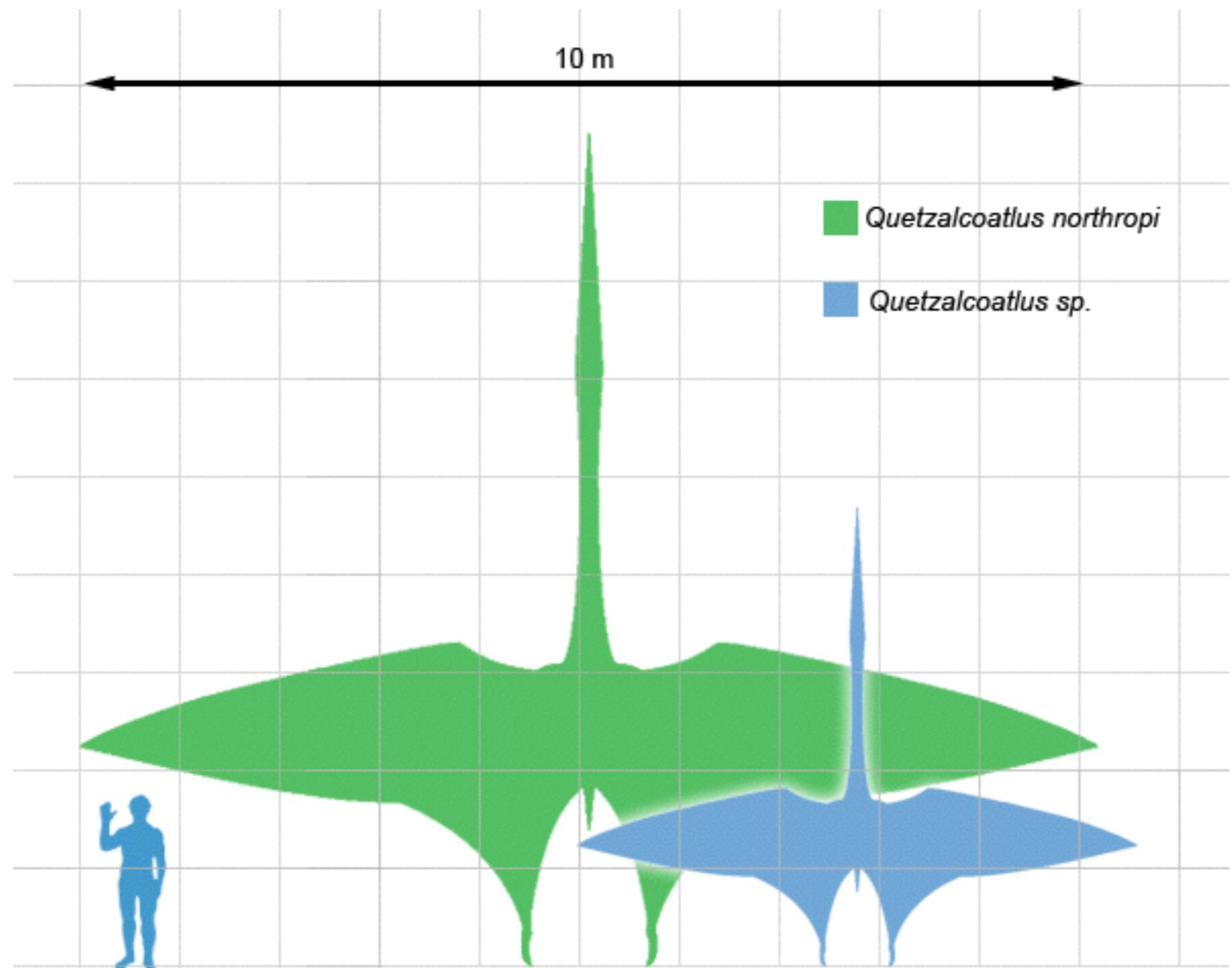
33 ft



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

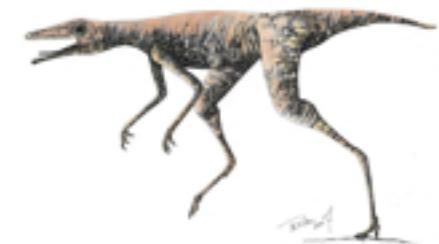
Ornithodira

Crown-clade Archosauria

Basal archosaurs

Archosauria

Pterosauria



Scleromochlus



Pterosauria



Lagosuchus



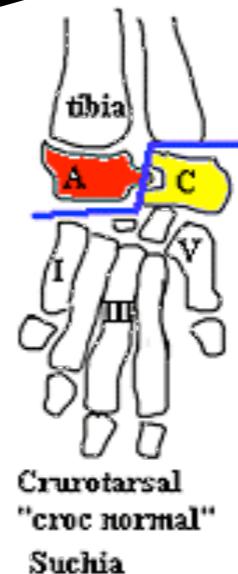
Aves



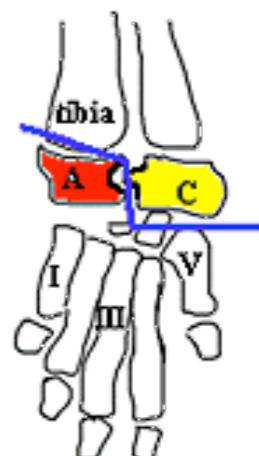
Dinosauria



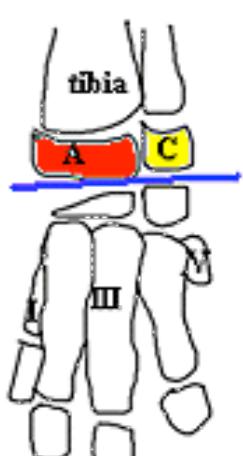
Ornithodira:
Upright gait
S-curved necks
Hinged Ankle



Crurotarsal
"croc normal"
Suchia

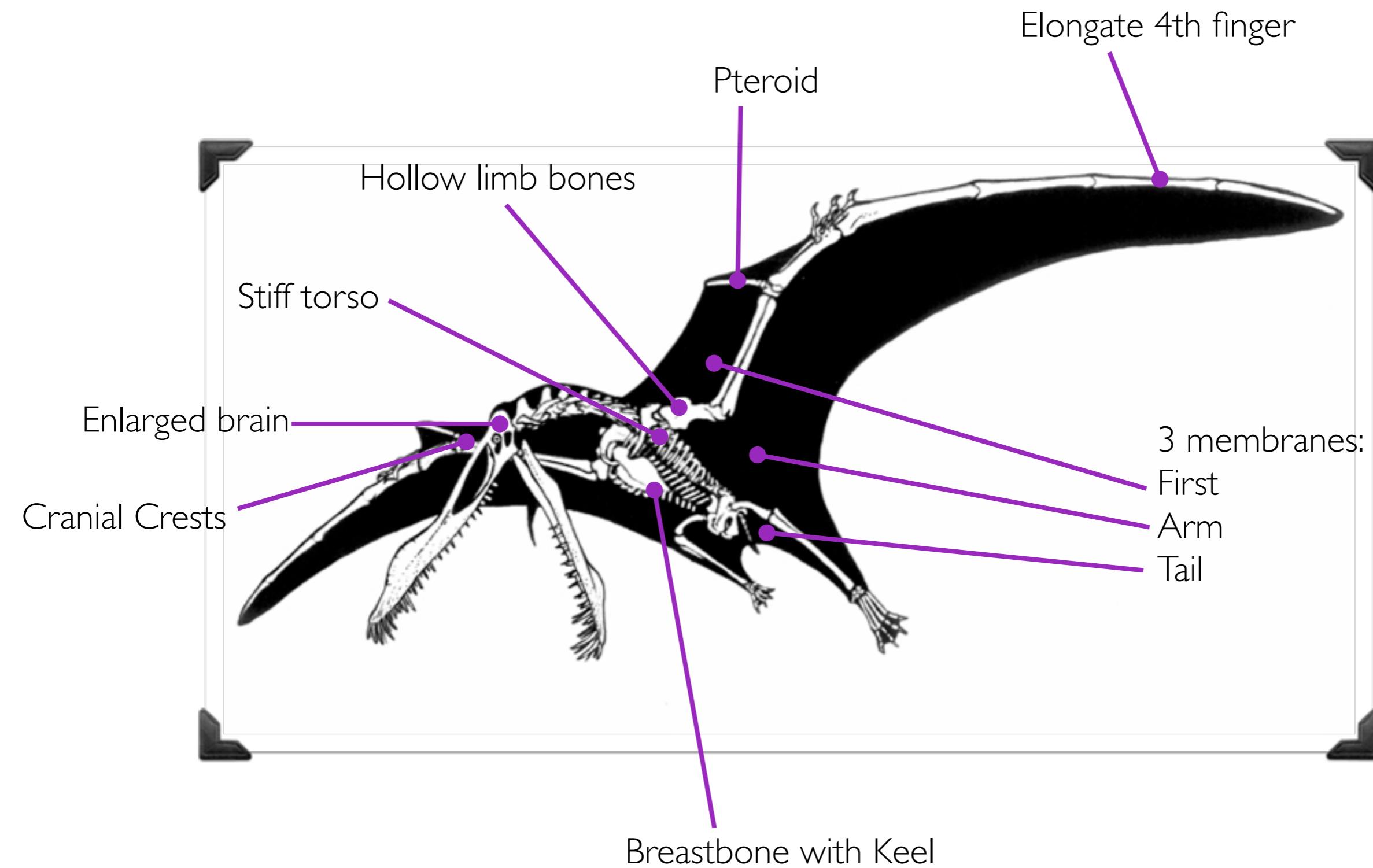


Crurotarsal
"croc reversed"
Ornithosuchia

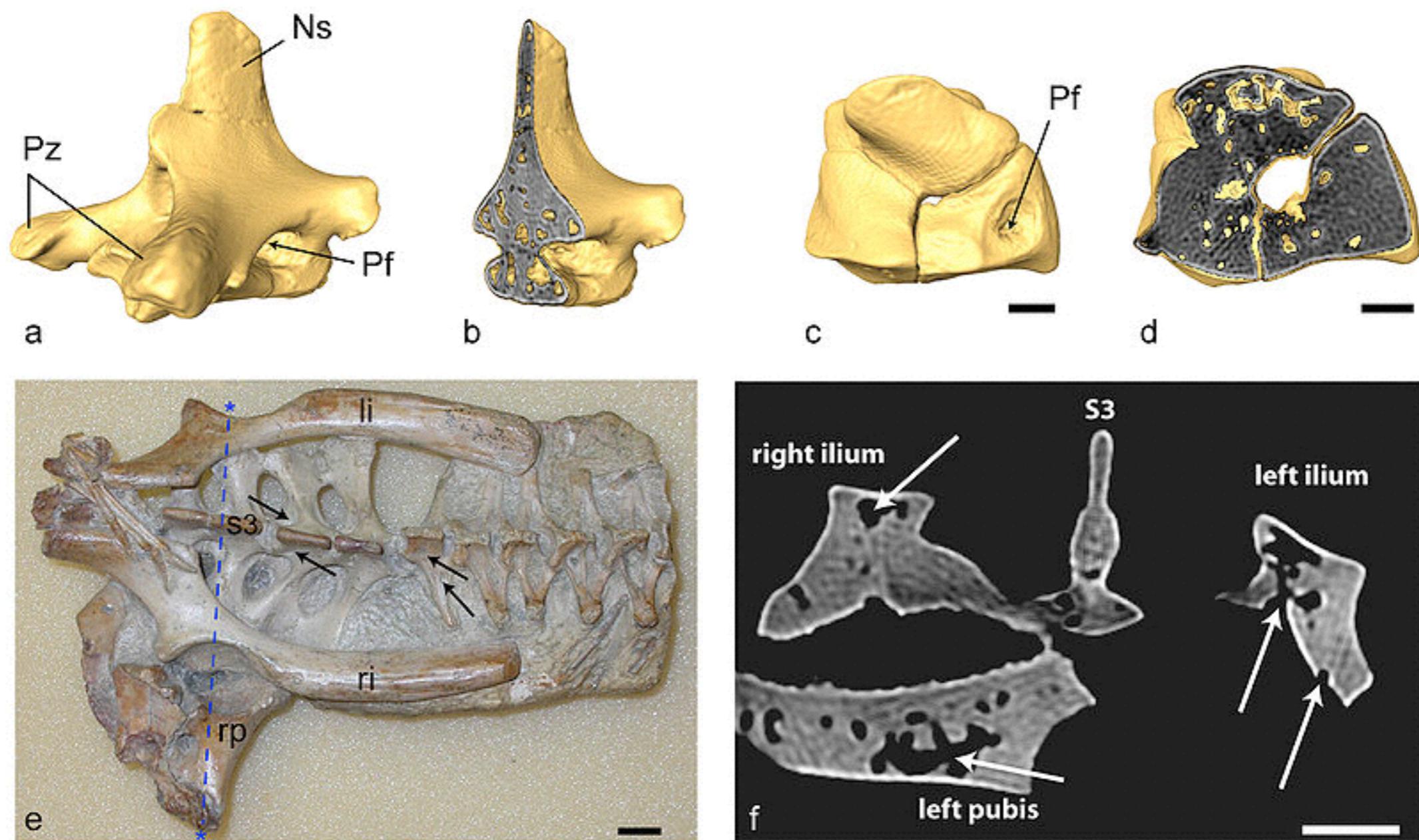


Mesotarsal
Ornithodira

Pterosaur Traits



Pterosaur Traits: pneumatic bones



Pterosaur Traits: air sacs



Pterosaur Traits: cranial crests Keratinous



Pteranodon



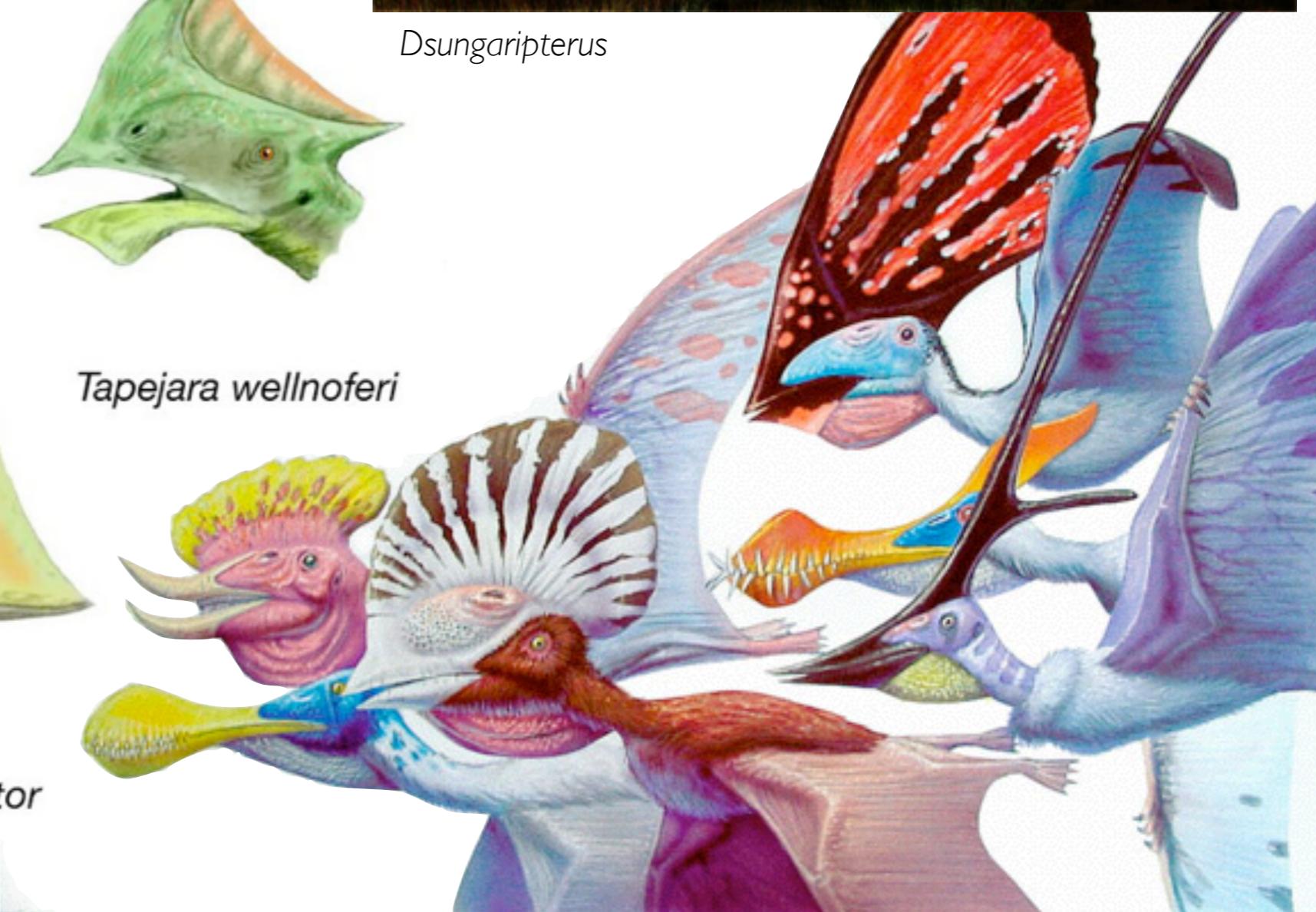
'Ingridia' navigans



Tupandactylus imperator



Tapejara wellnoferi



Dsungaripterus

Pterosaur Traits: cranial crests

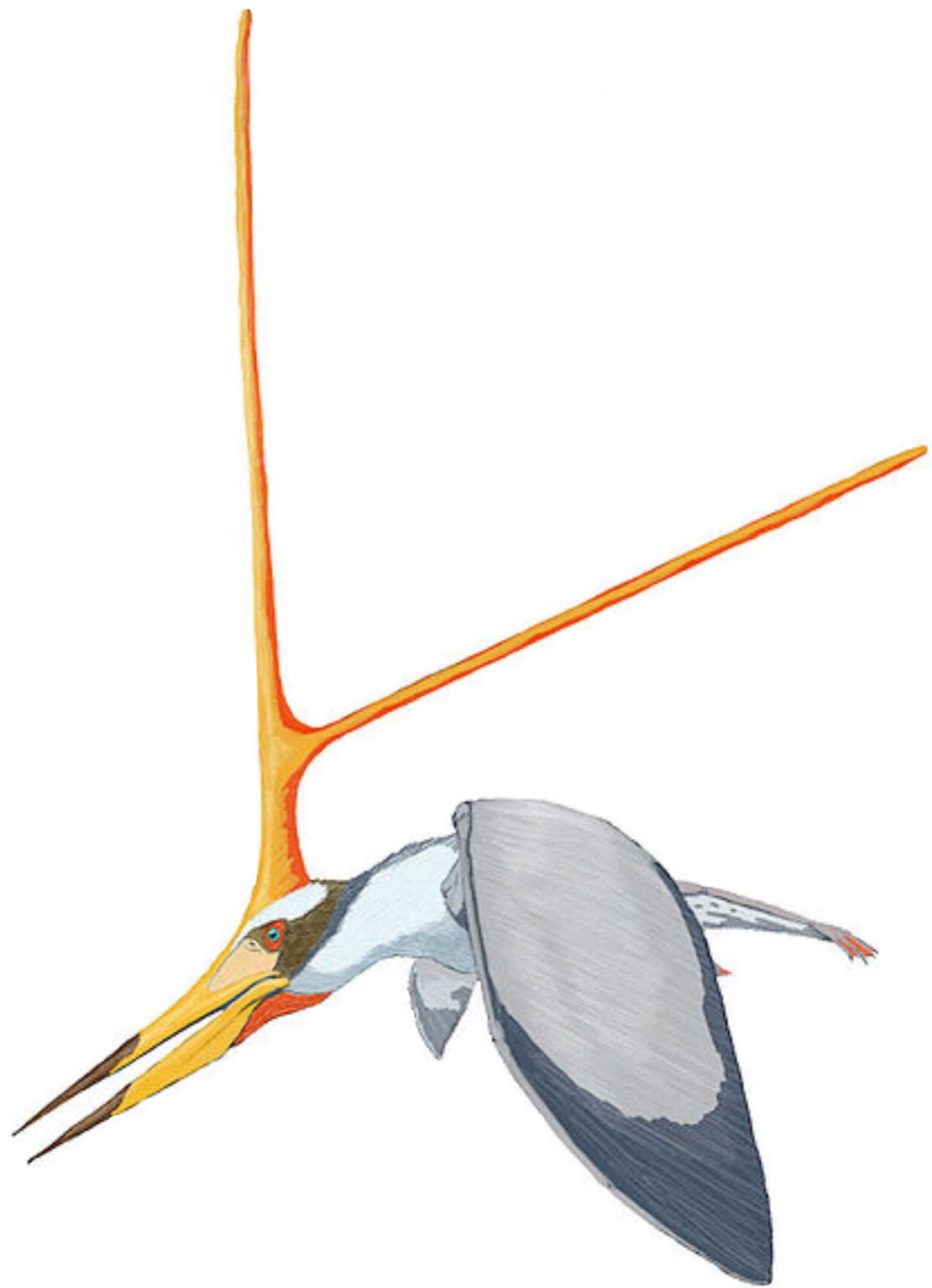
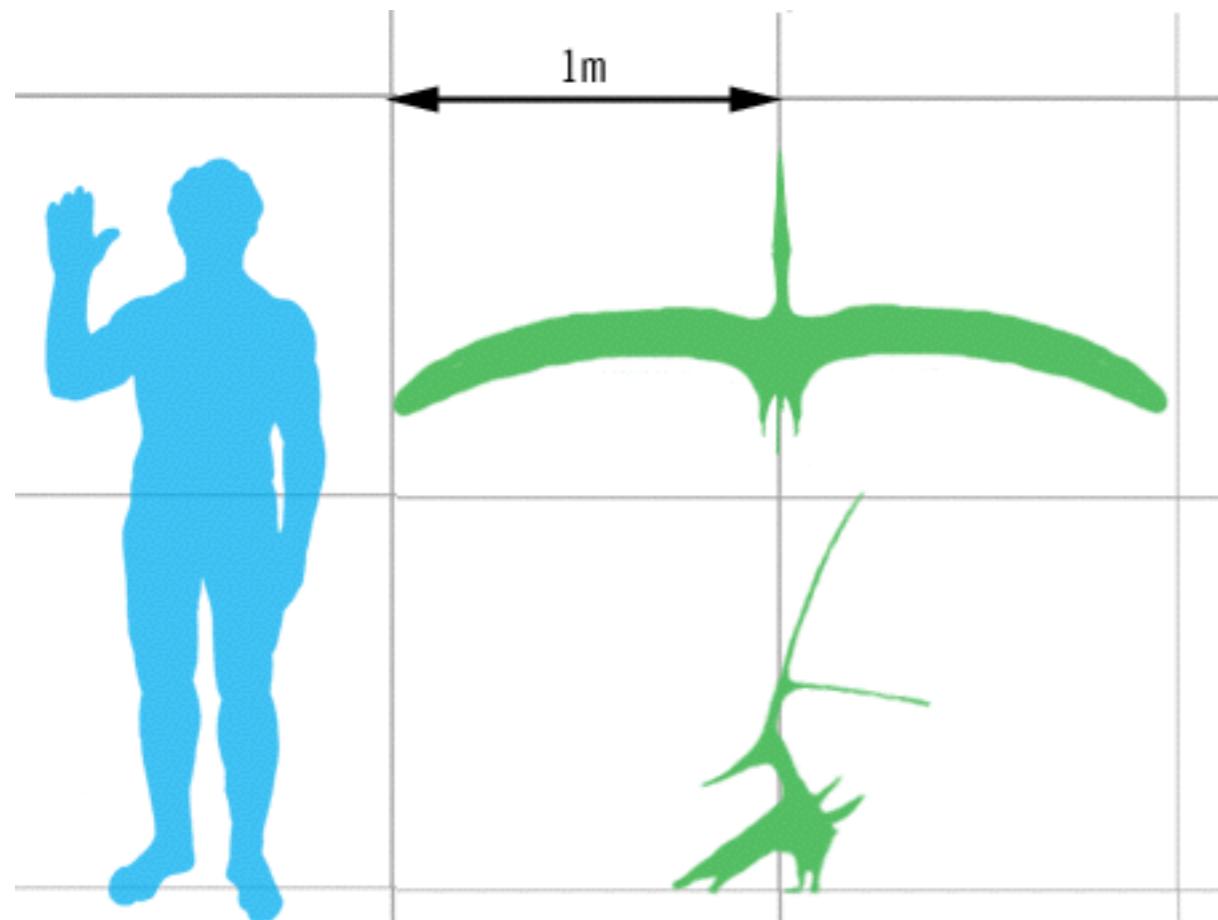
Keratinous



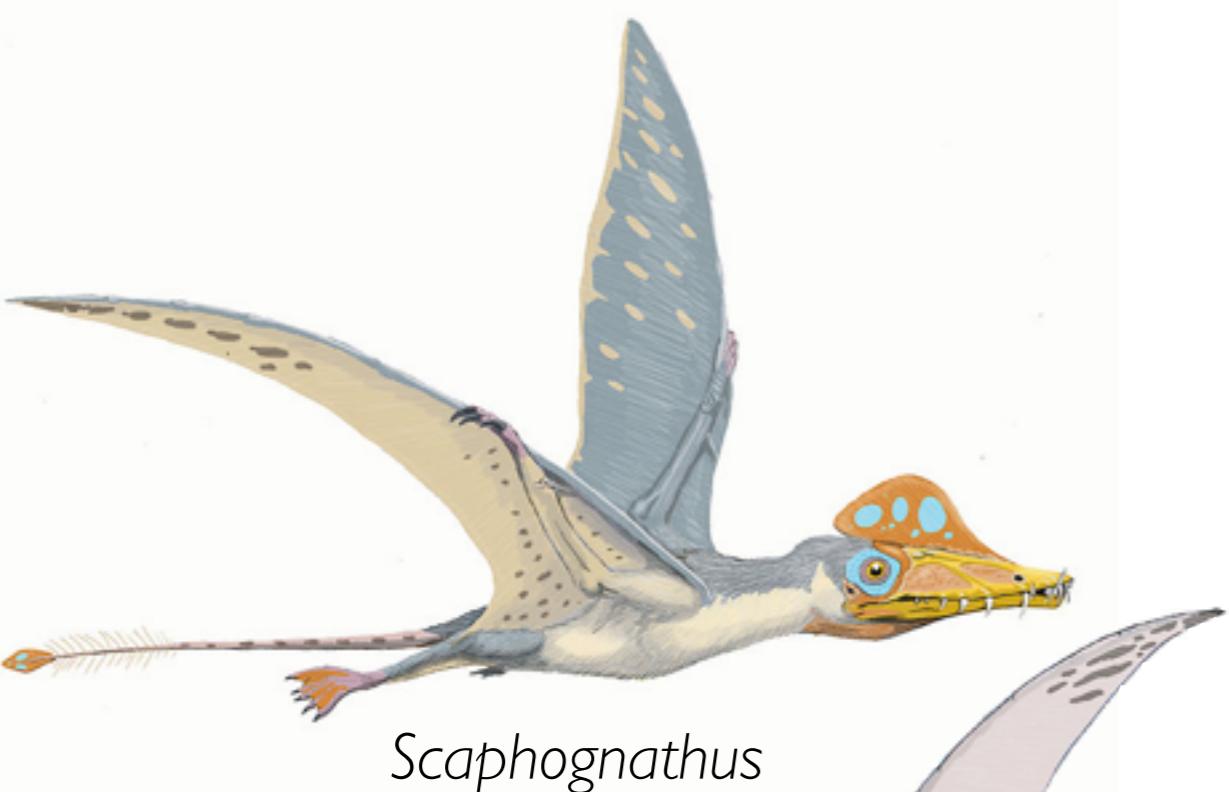
Pterosaur Traits: cranial crests

Nyctosaurus; late Cretaceous

Sometime, ridiculous things happen.



Pterosaur Traits: jaw diversity



Scaphognathus



Sordes

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

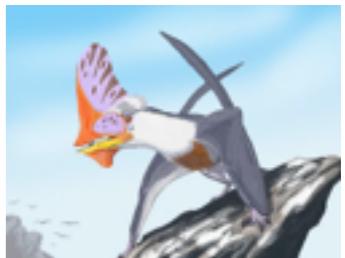


Dorygnathus



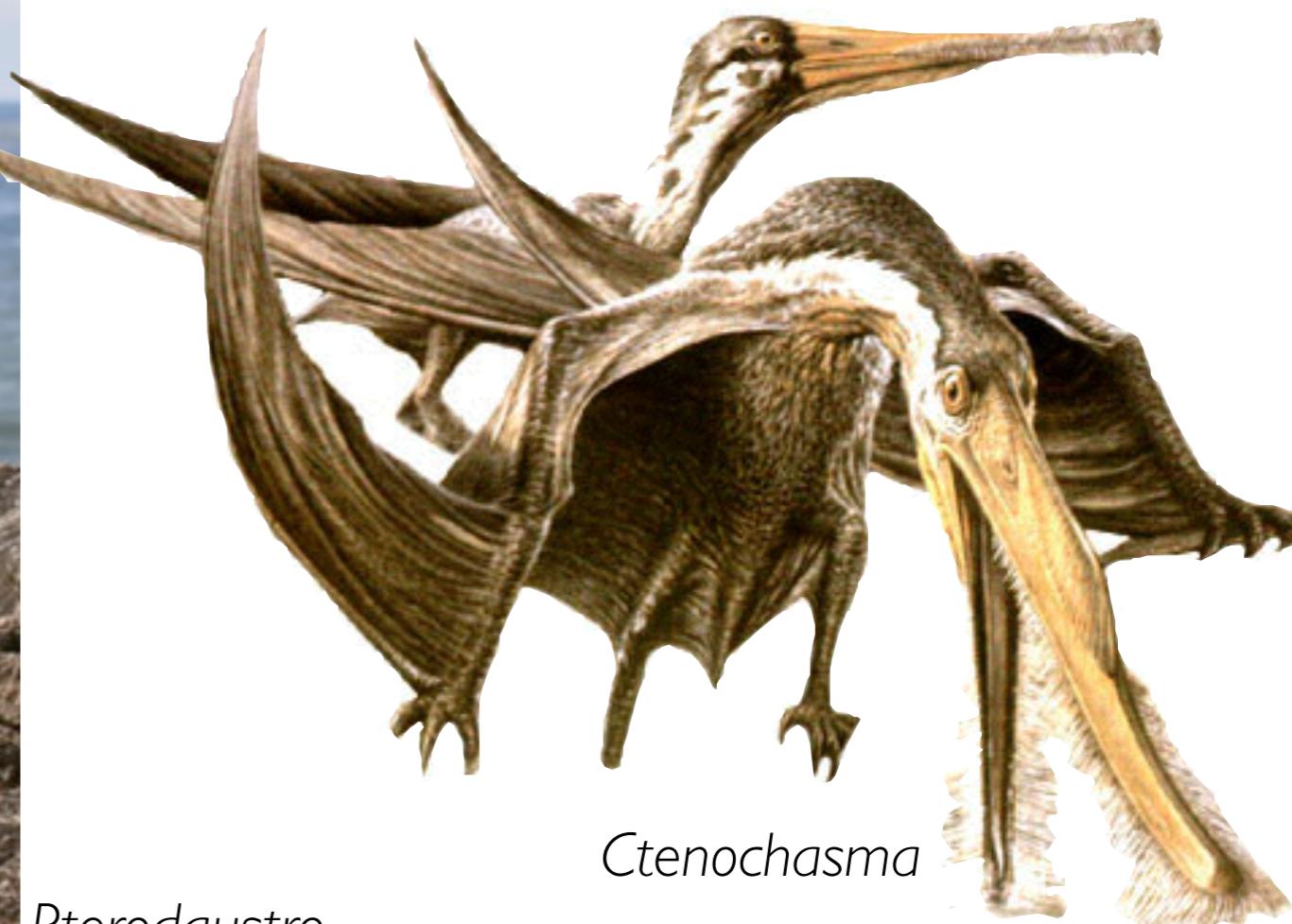
Campylorhynchoides

Ramphorynchids





Dimorphodon



Pterodaustro

Ctenochasma

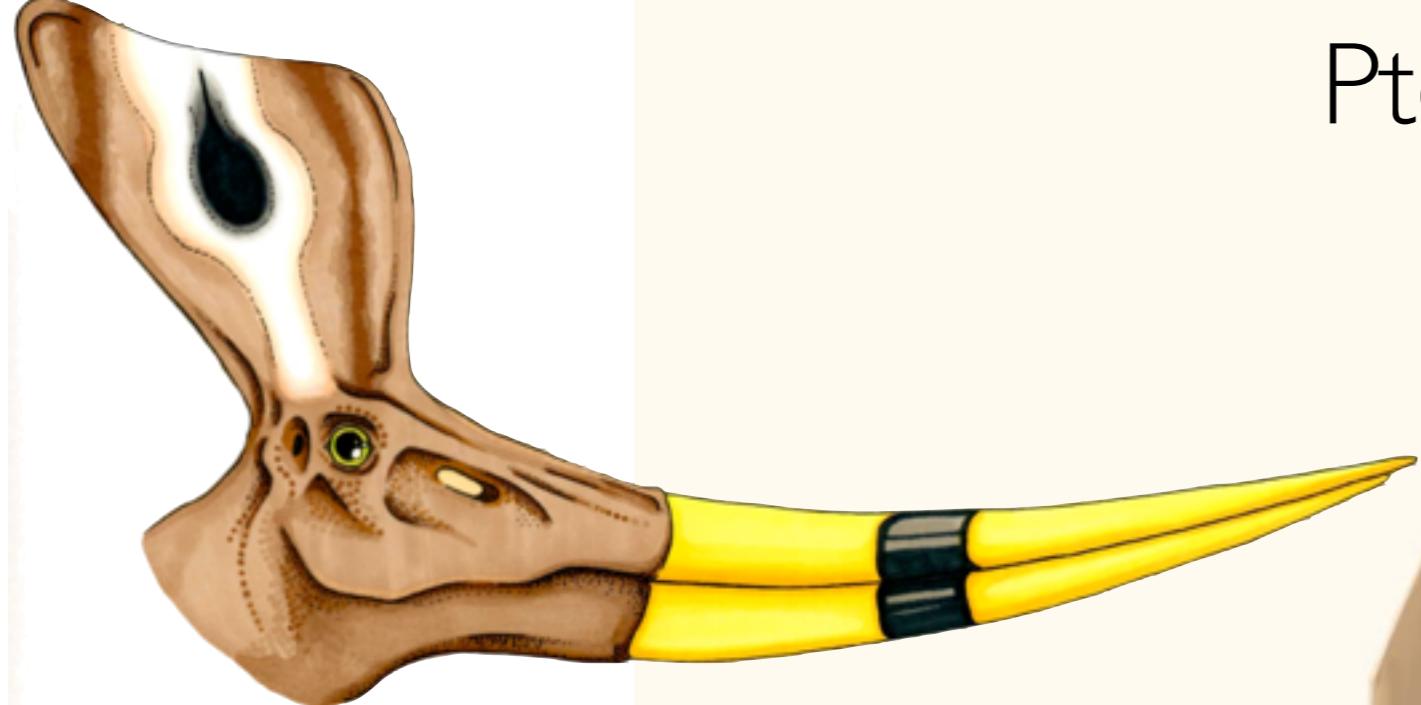


Ornithocheirus

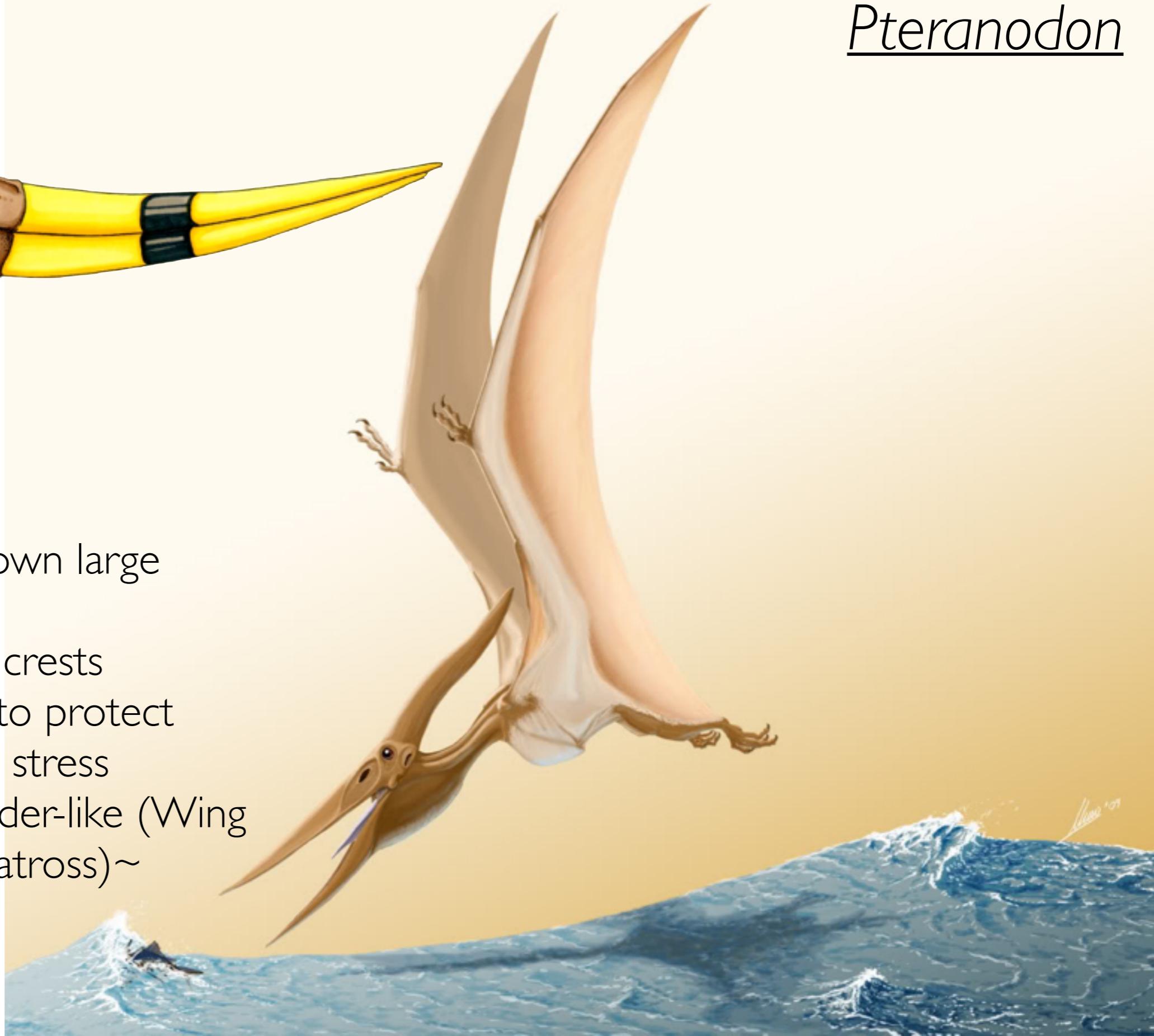
Fisheaters, Filterers

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



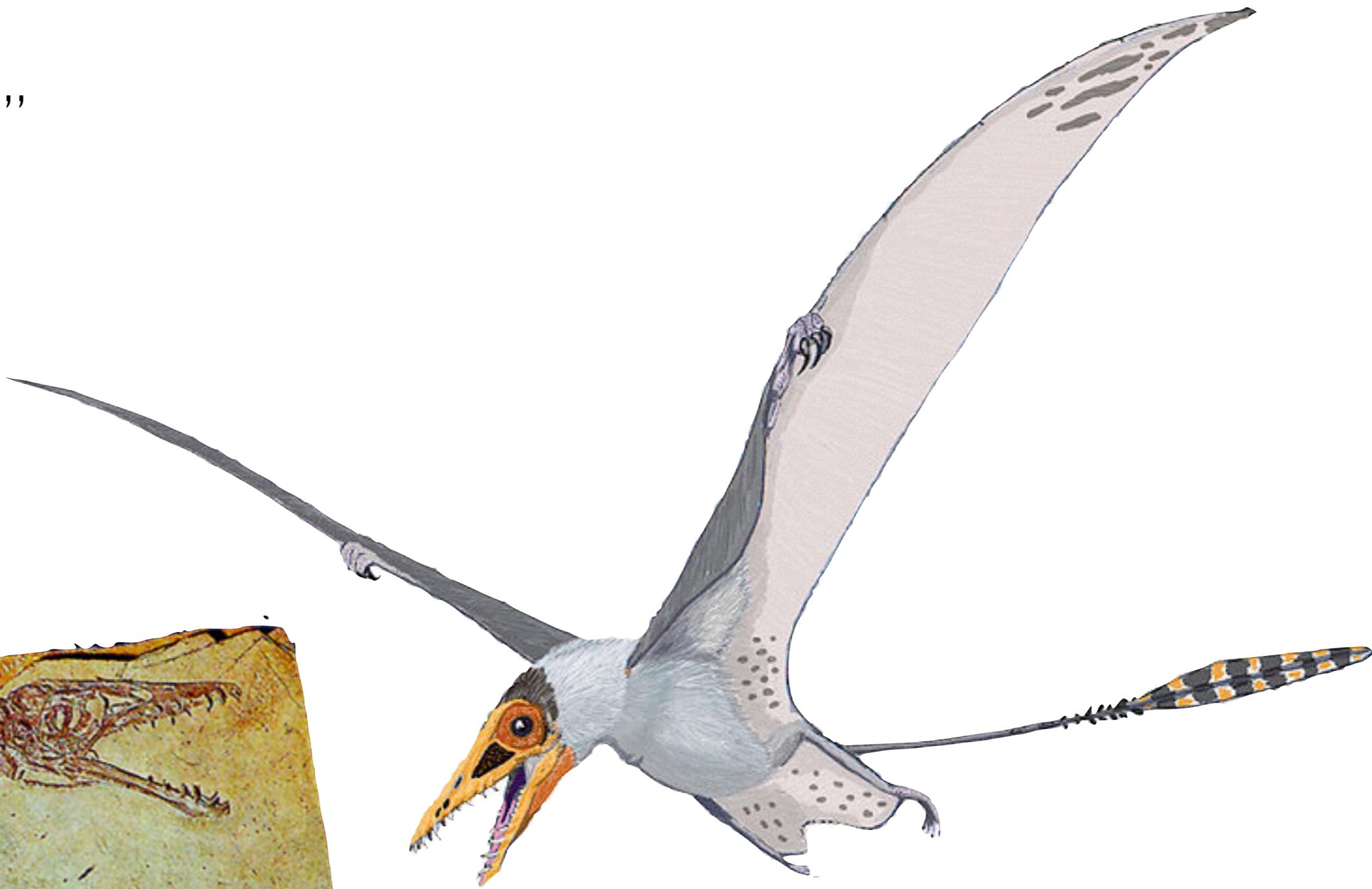


Pterosaur Traits: skin



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

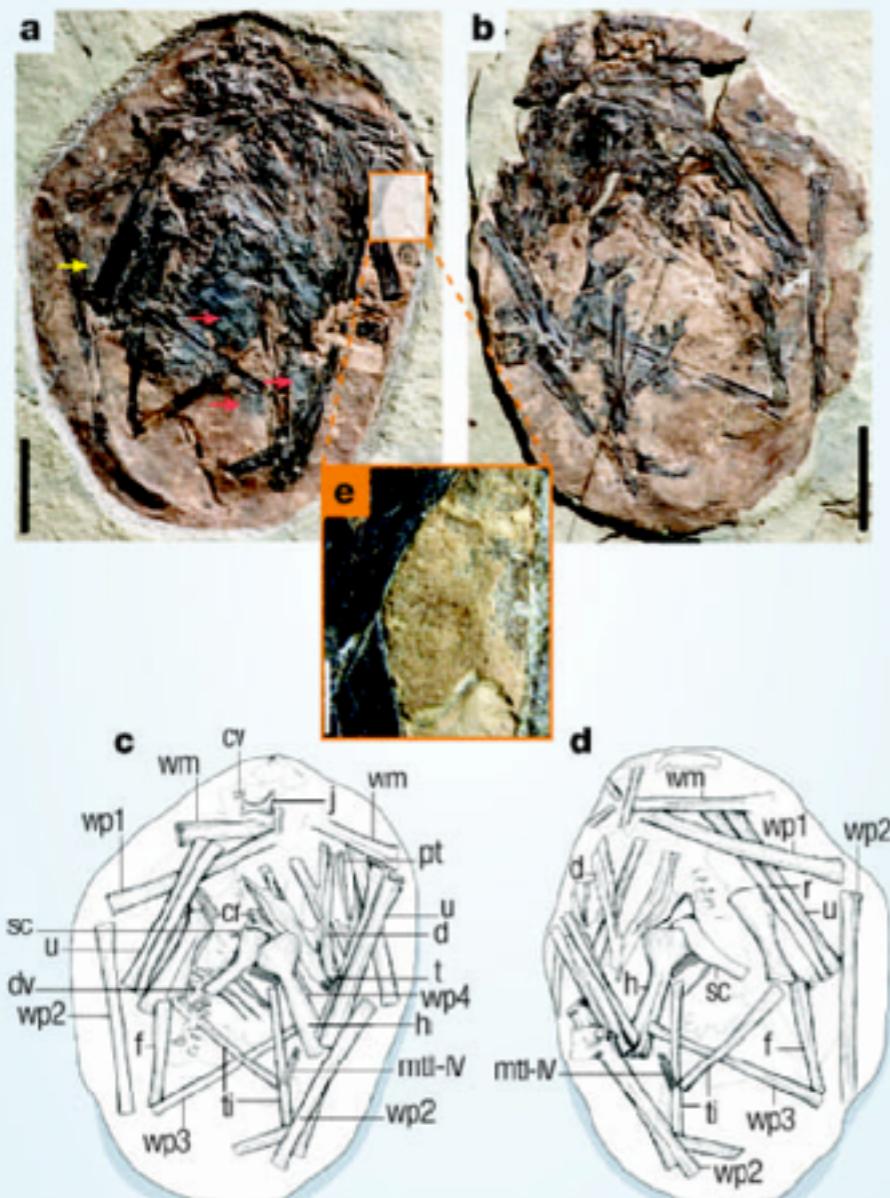


Figure 1 Pterosaur embryo inside an egg from the Early Cretaceous period from Liaoning, China (VPP V13758). **a–d**, Photographs of part (a) and counterpart (b) of the fossil and their corresponding line drawings (c, d; not to scale). Red arrows indicate skin imprints and the yellow arrow indicates the 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; mtI–IV, metatarsals I–IV; pt, pteroid; 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

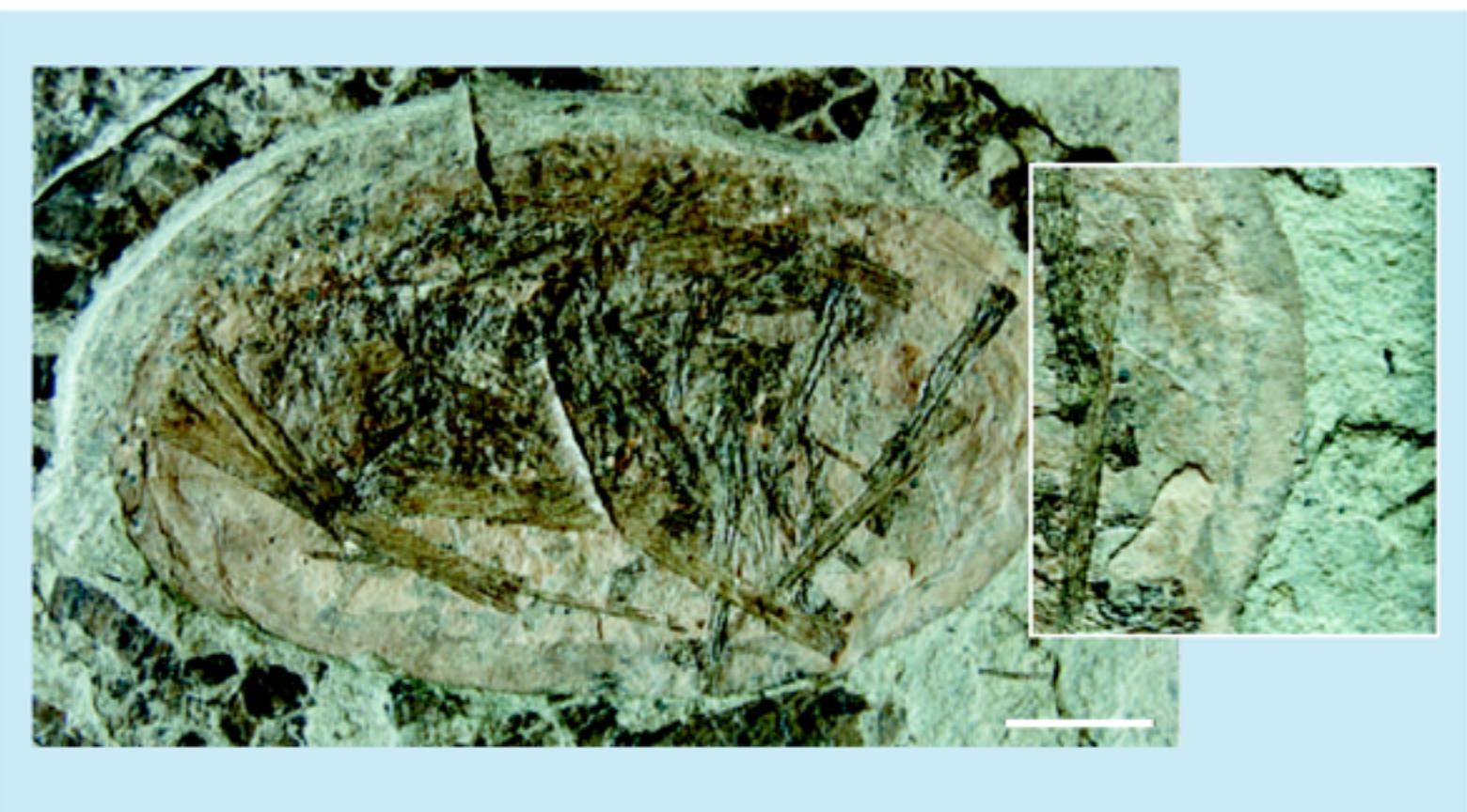
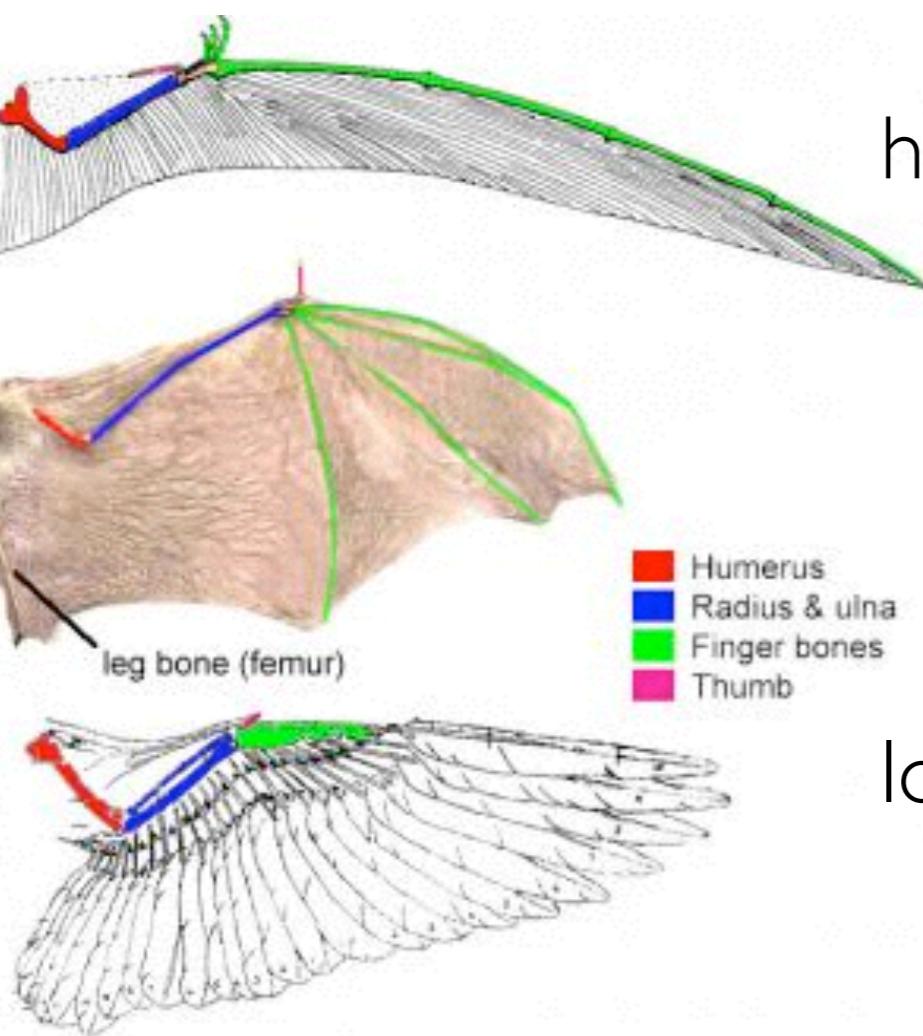


Figure 1 Early Cretaceous pterosaur egg and embryo (JZMP-03-03-2) from the Yixian Formation of Liaoning, China. Scale bar, 1 cm. Inset, magnification of egg boundary (130%) showing the thin, soft shell and no evidence of lamination structures. For composite drawing of the specimen, see supplementary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

Pterosaur Flight



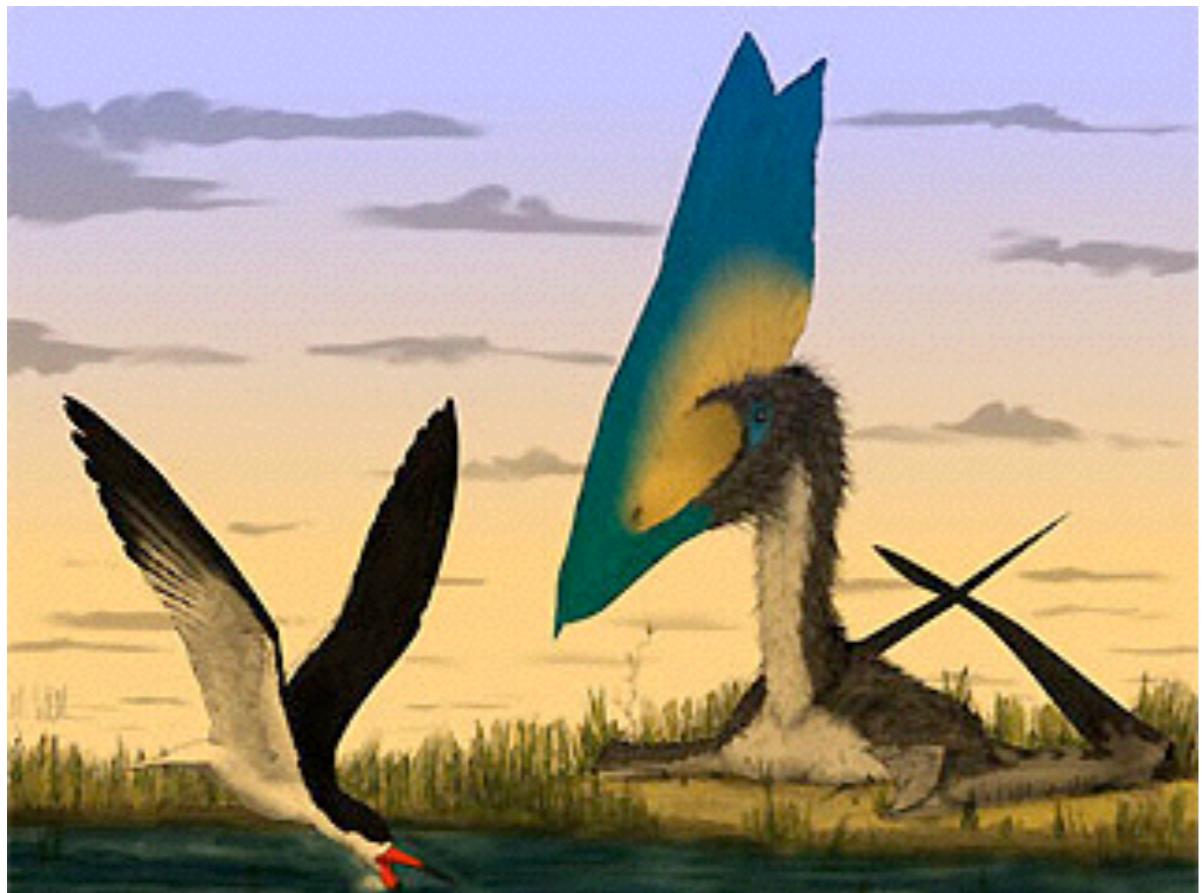


high aspect ratio
(long, slender)

low aspect ratio
(short, squat)



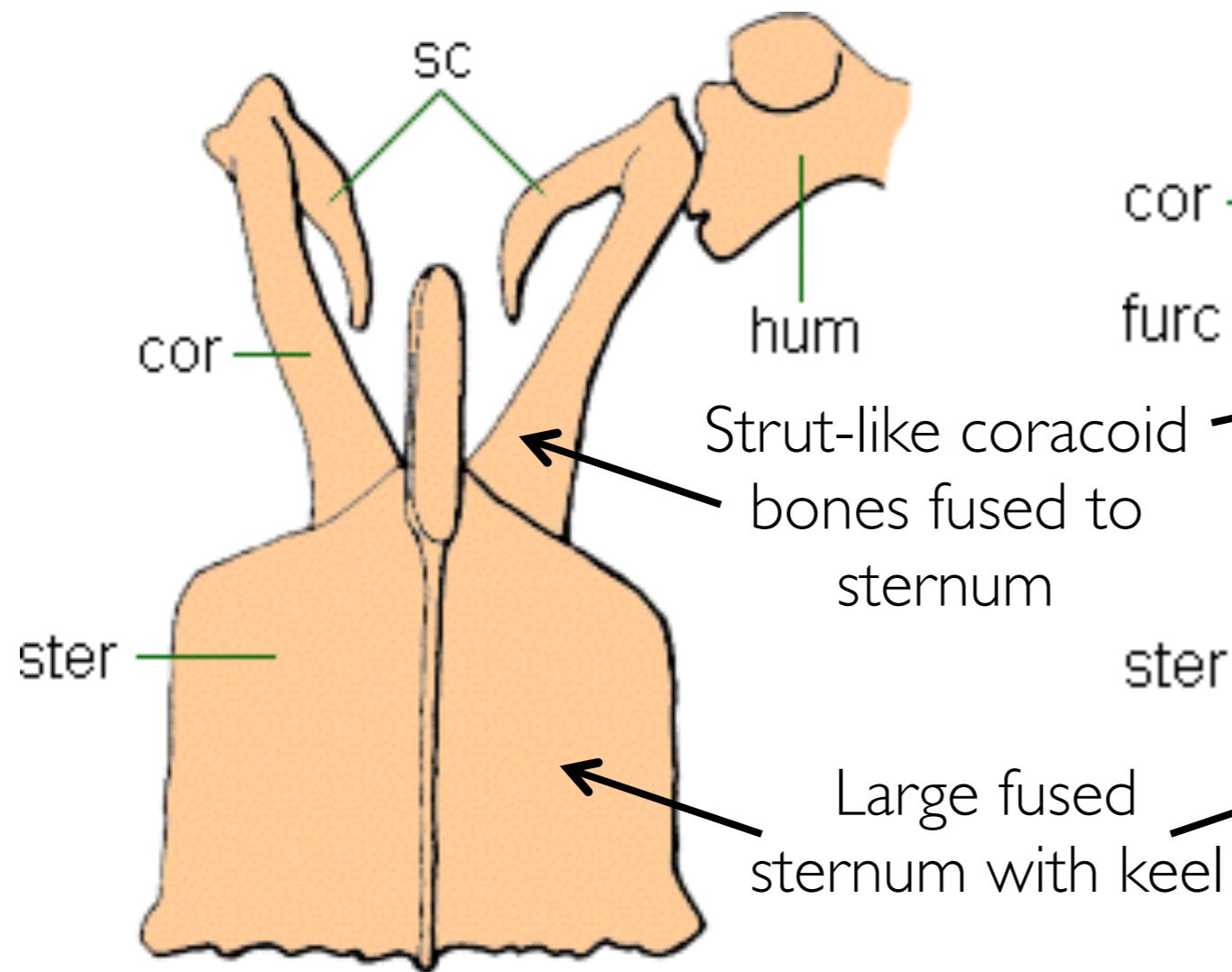
Convergent Flight Adaptations in Pterosaurs



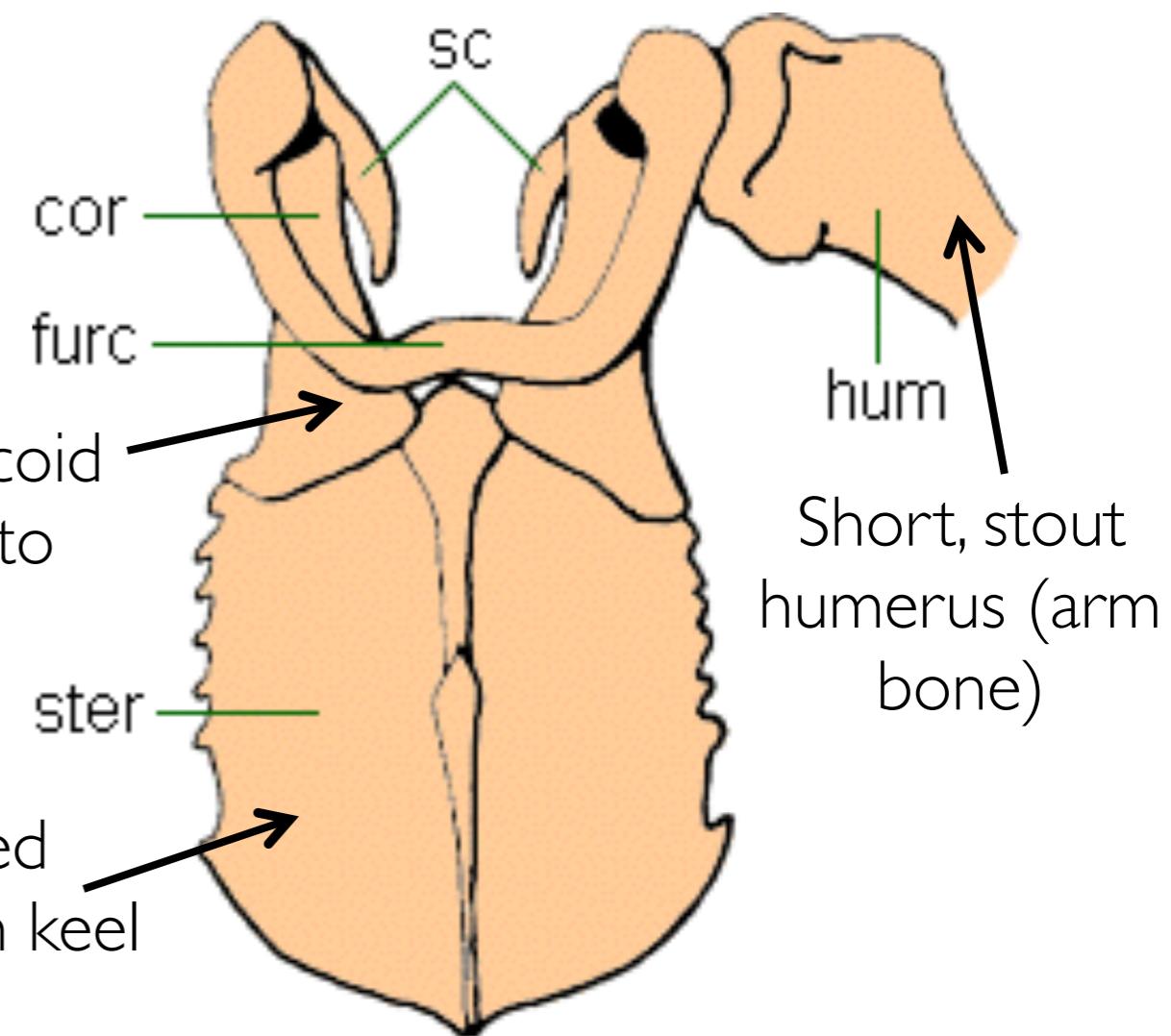
Pectoral Girdle Similarities

Pterosaurs independently evolved a pectoral girdle for supporting flight muscles

Pterosaur pectoral girdle

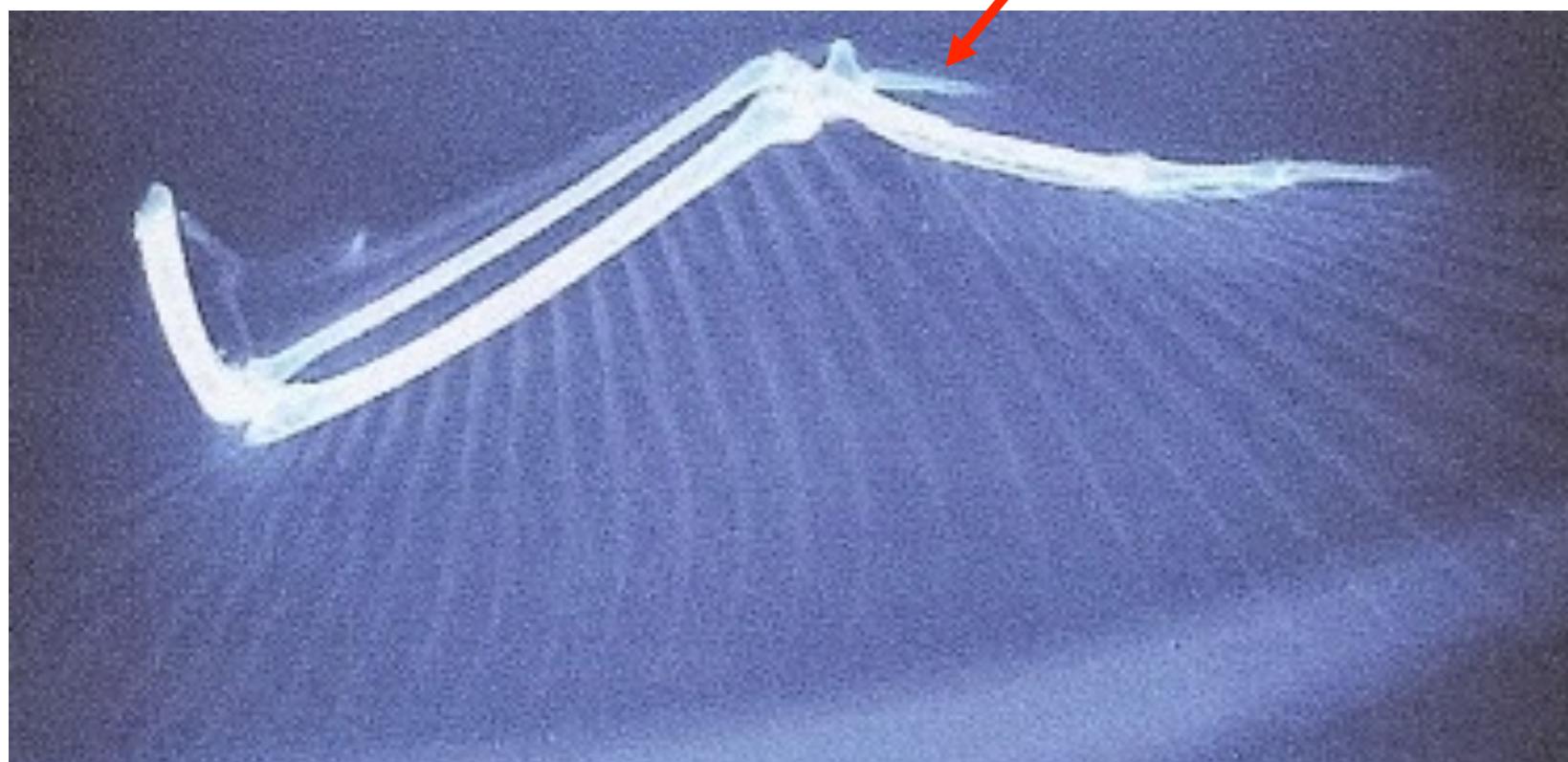
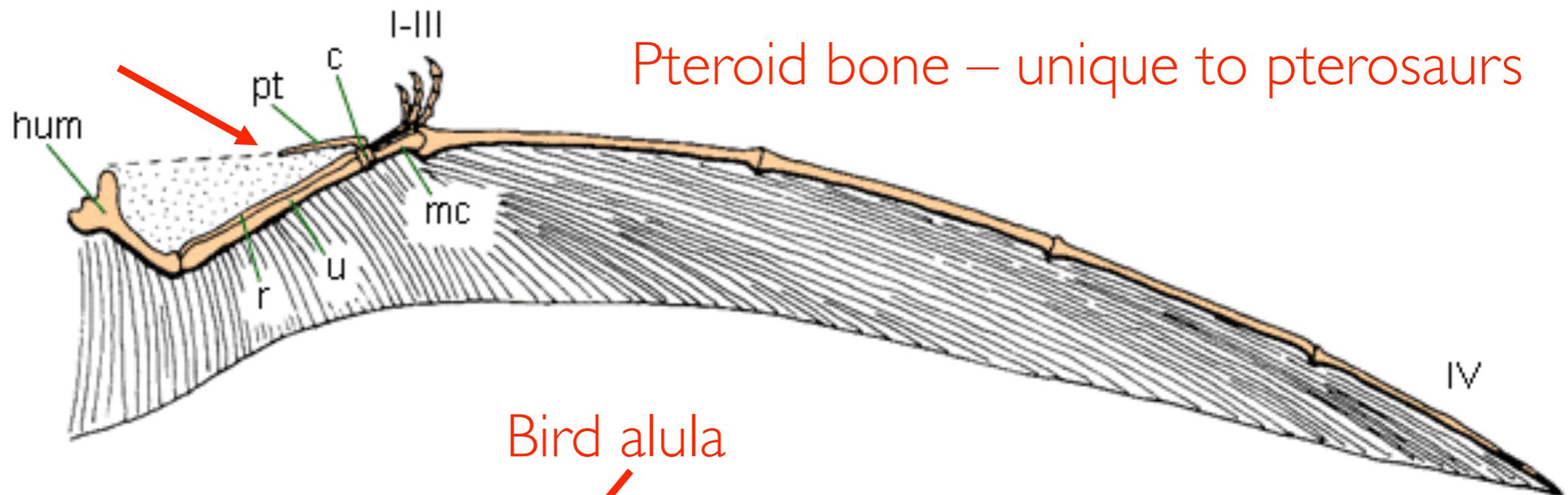


Avian pectoral girdle



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



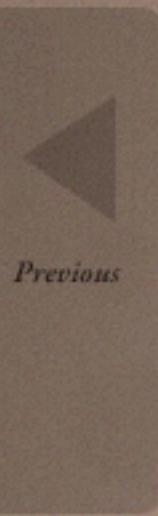
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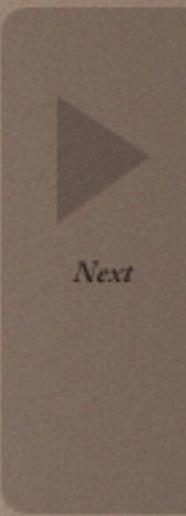
Dissecting
Rhamphorhynchus



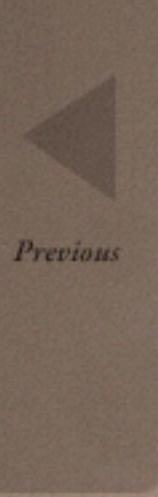
Next



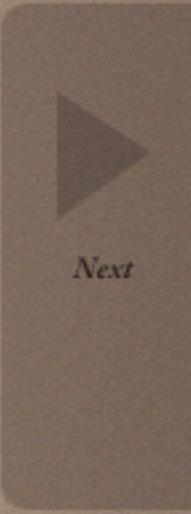
Previous



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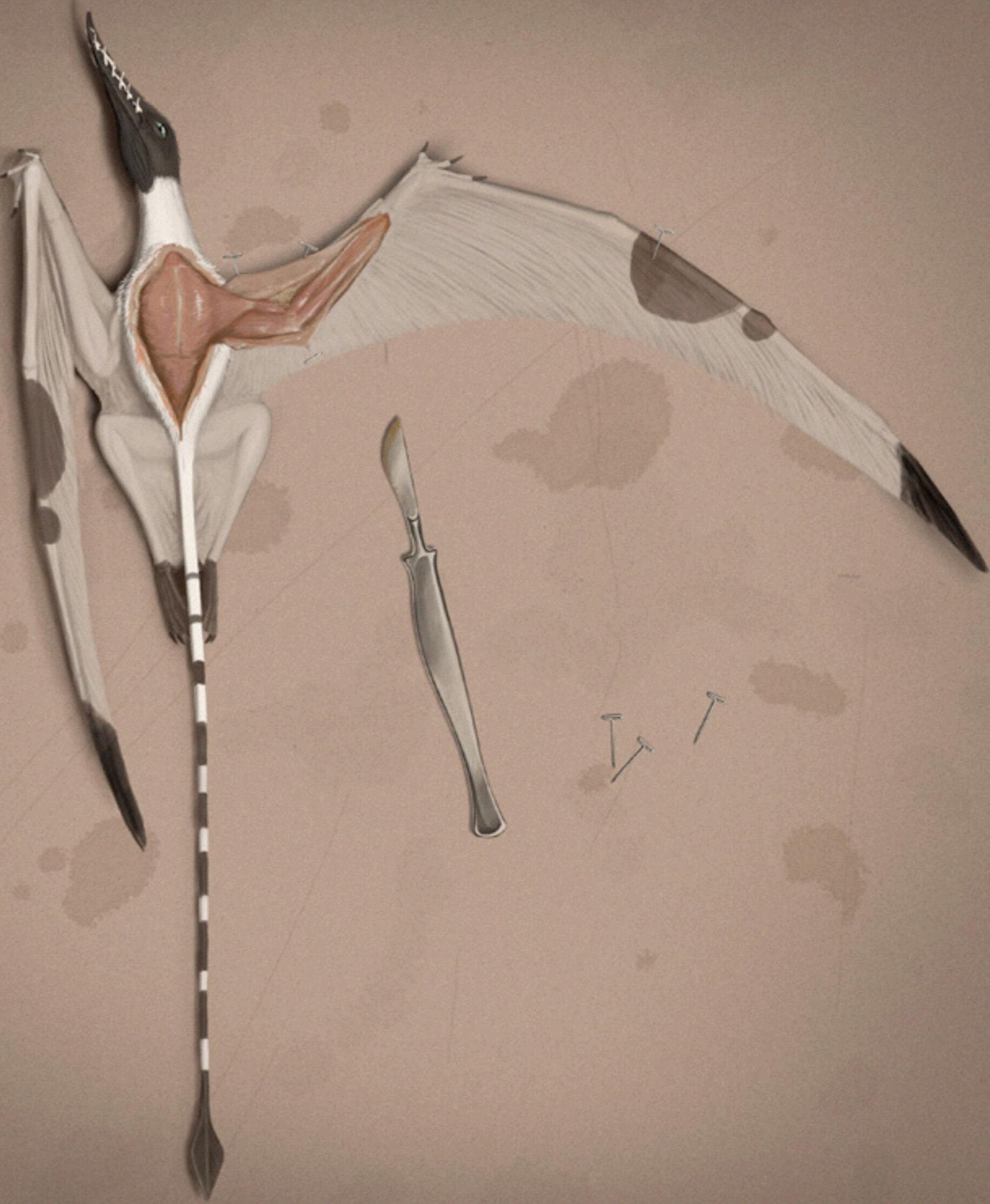


Previous



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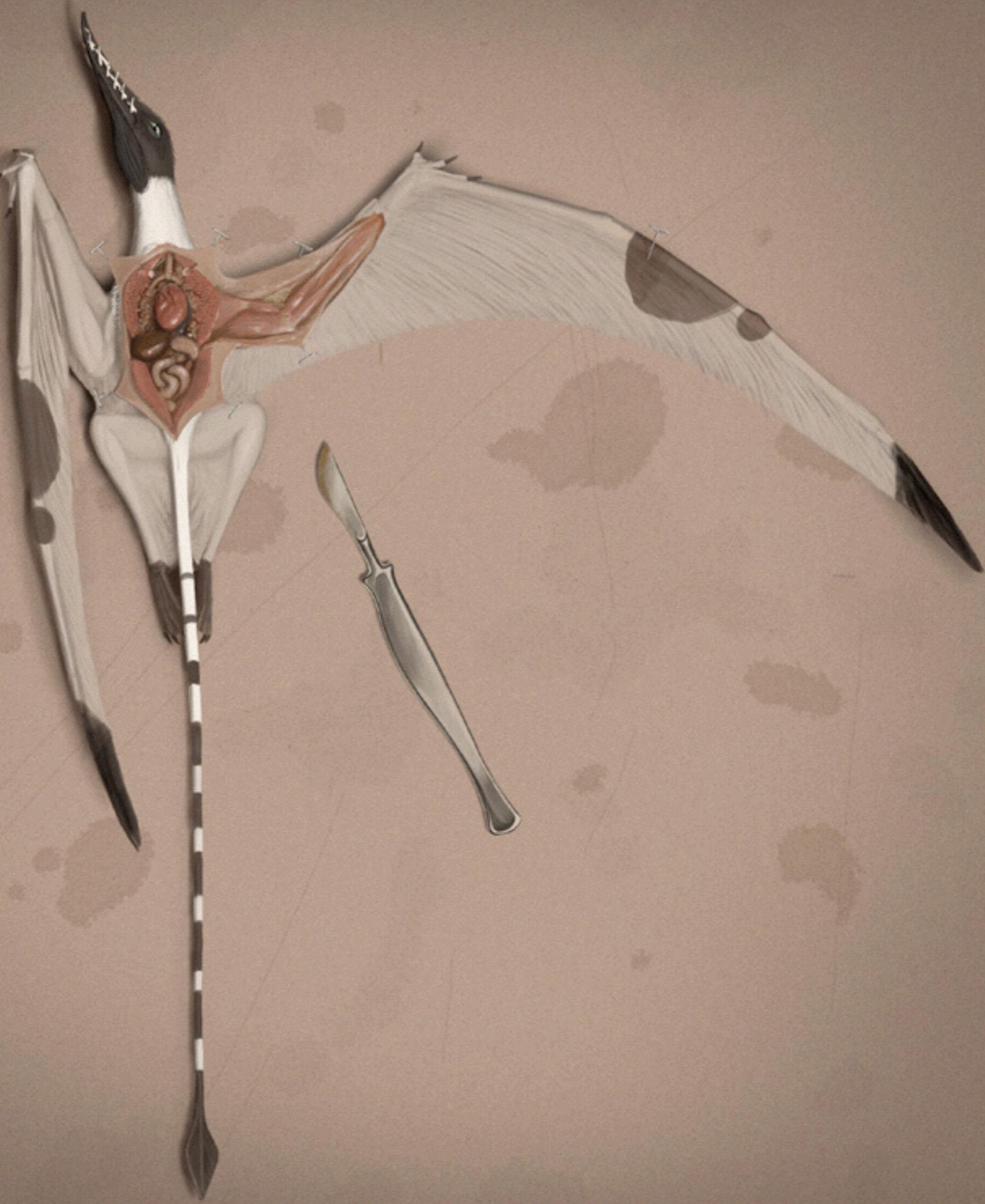
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Previous



Unique Flight Adaptations in Pterosaurs

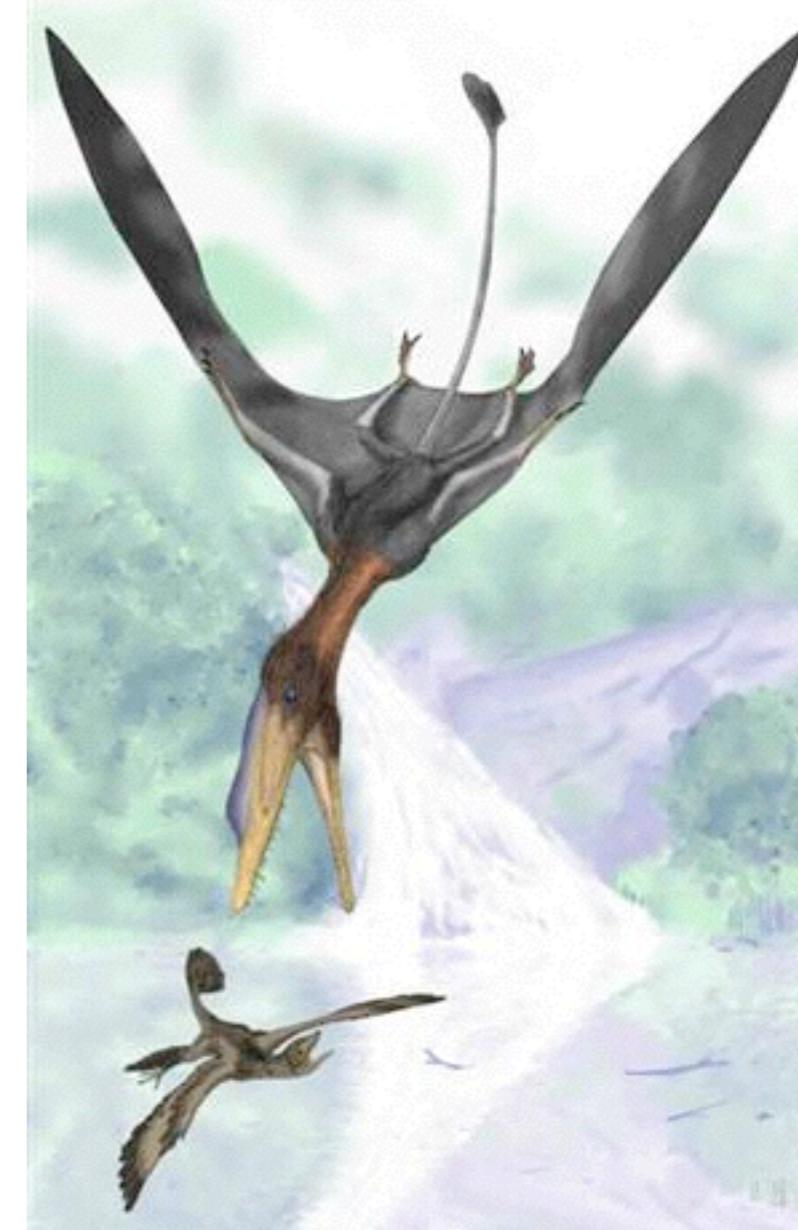
Wing support

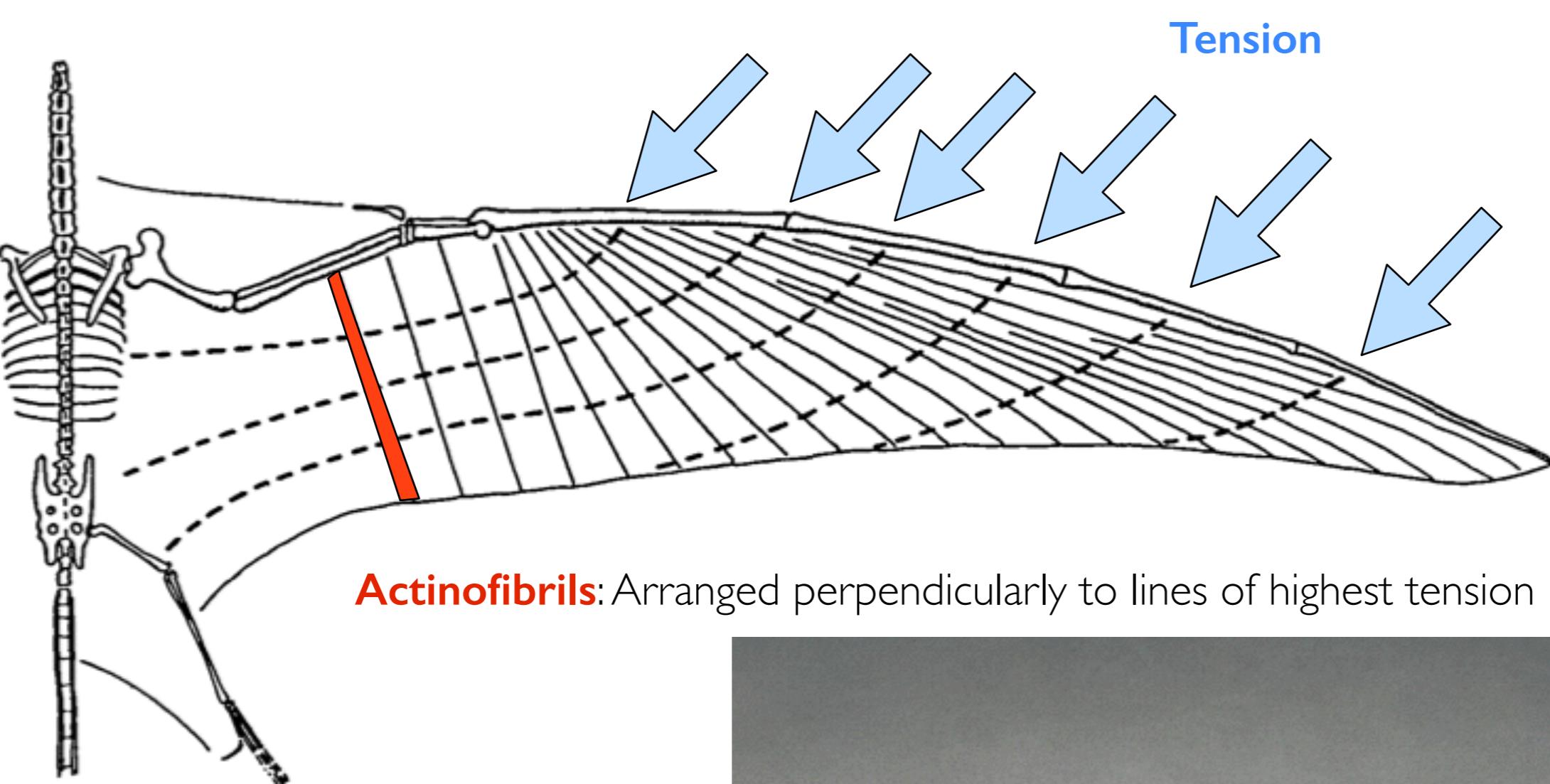
Outer wing supported by **Actinofibrils**

3 distinct layers of criss-crossed fibers

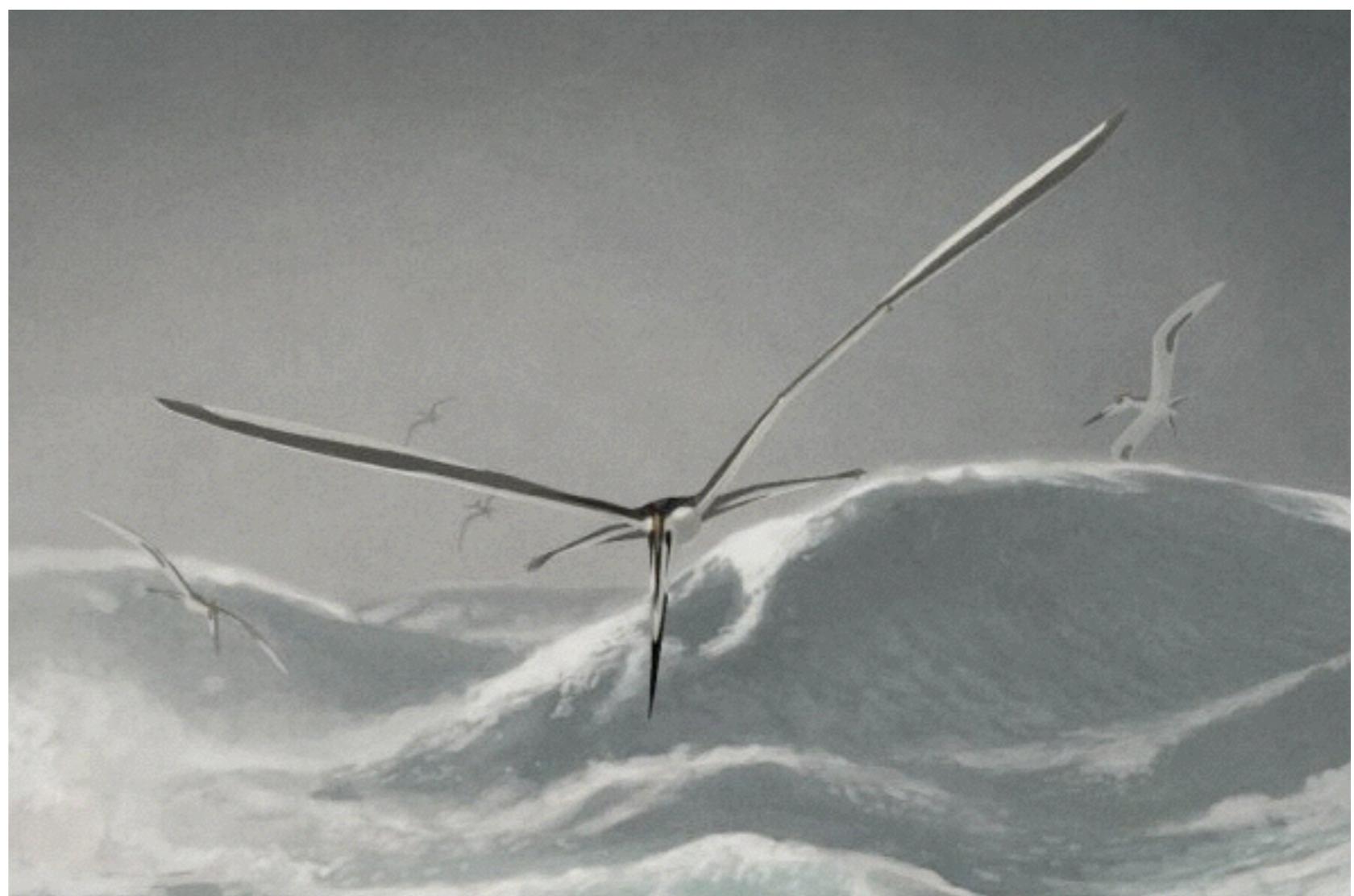
Keratin? Elastin? Unknown.

Oxygenated by looping blood vessels



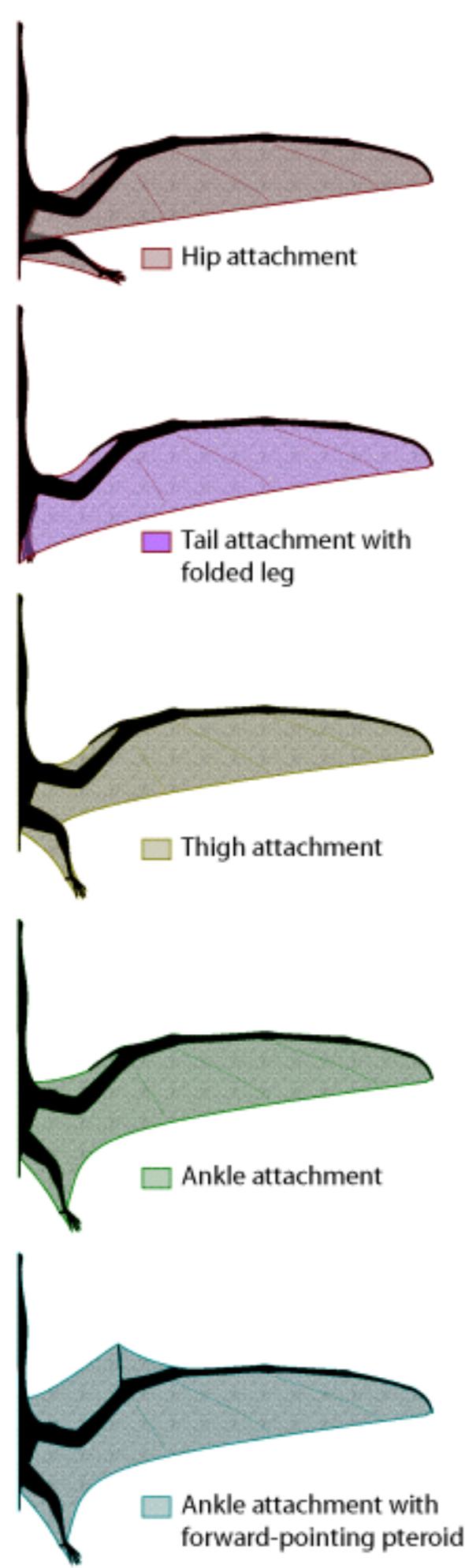


Actinofibrils: Arranged perpendicularly to lines of highest tension in wing

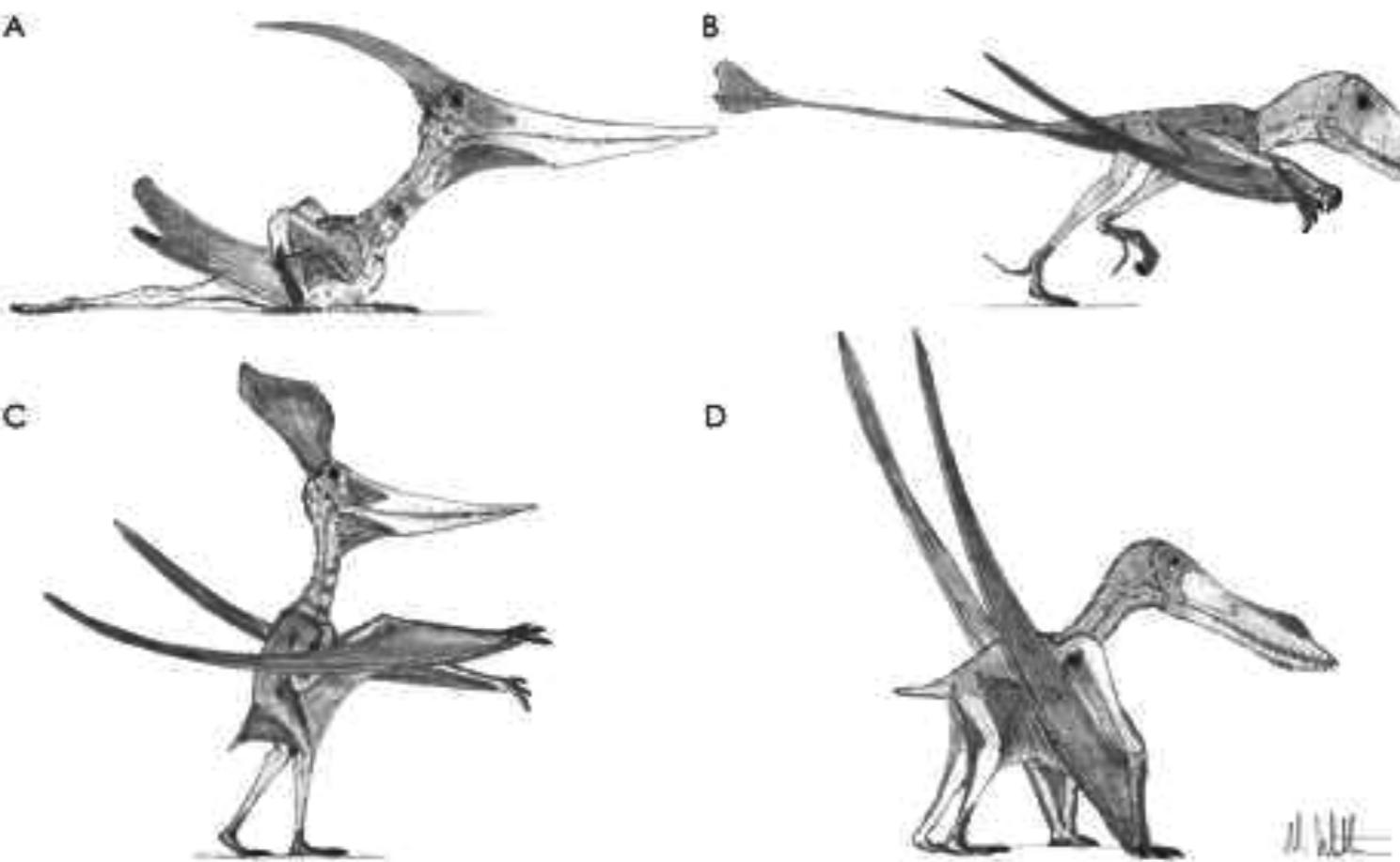


Alternative Wing Structures

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



Pterosaur Walking



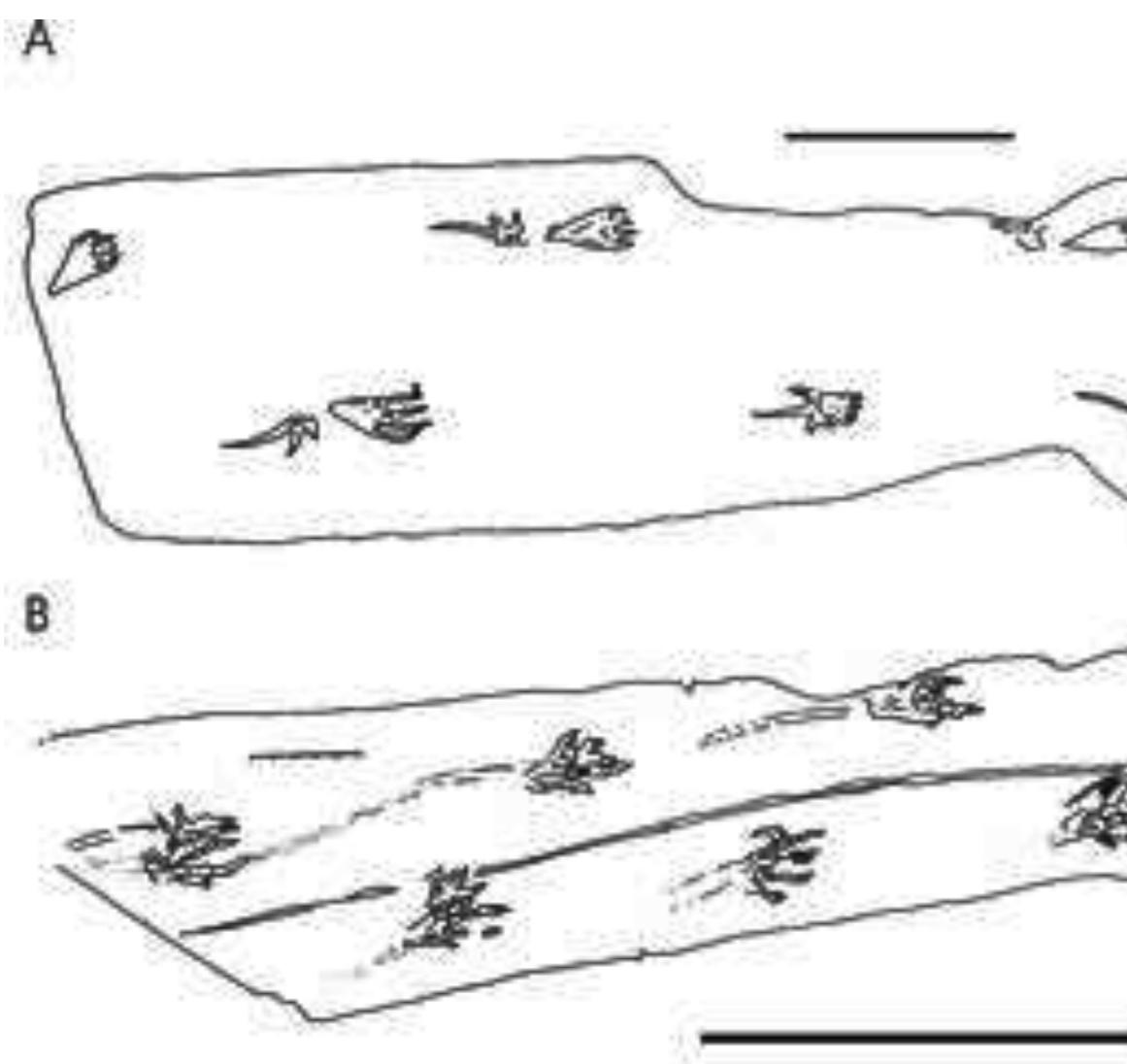
An evolving concept...

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

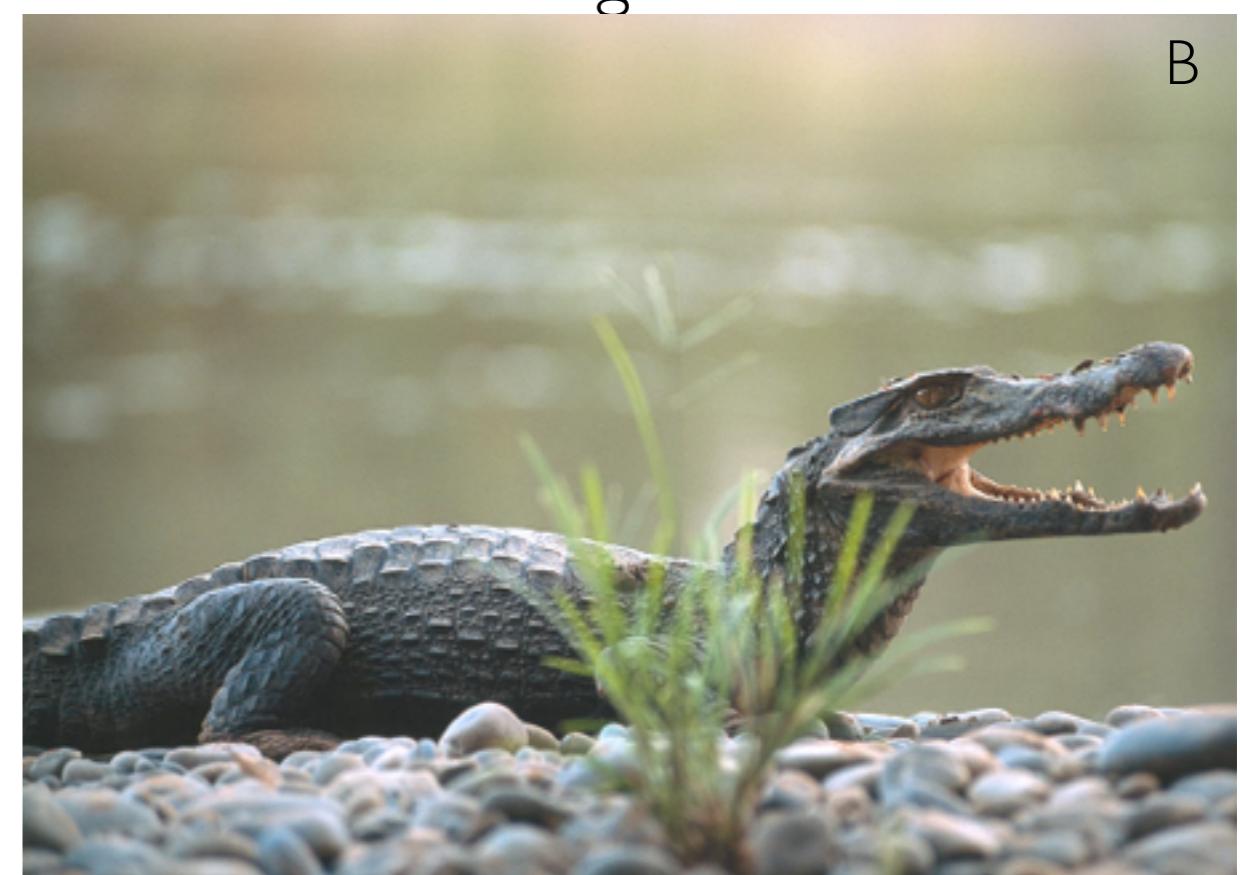
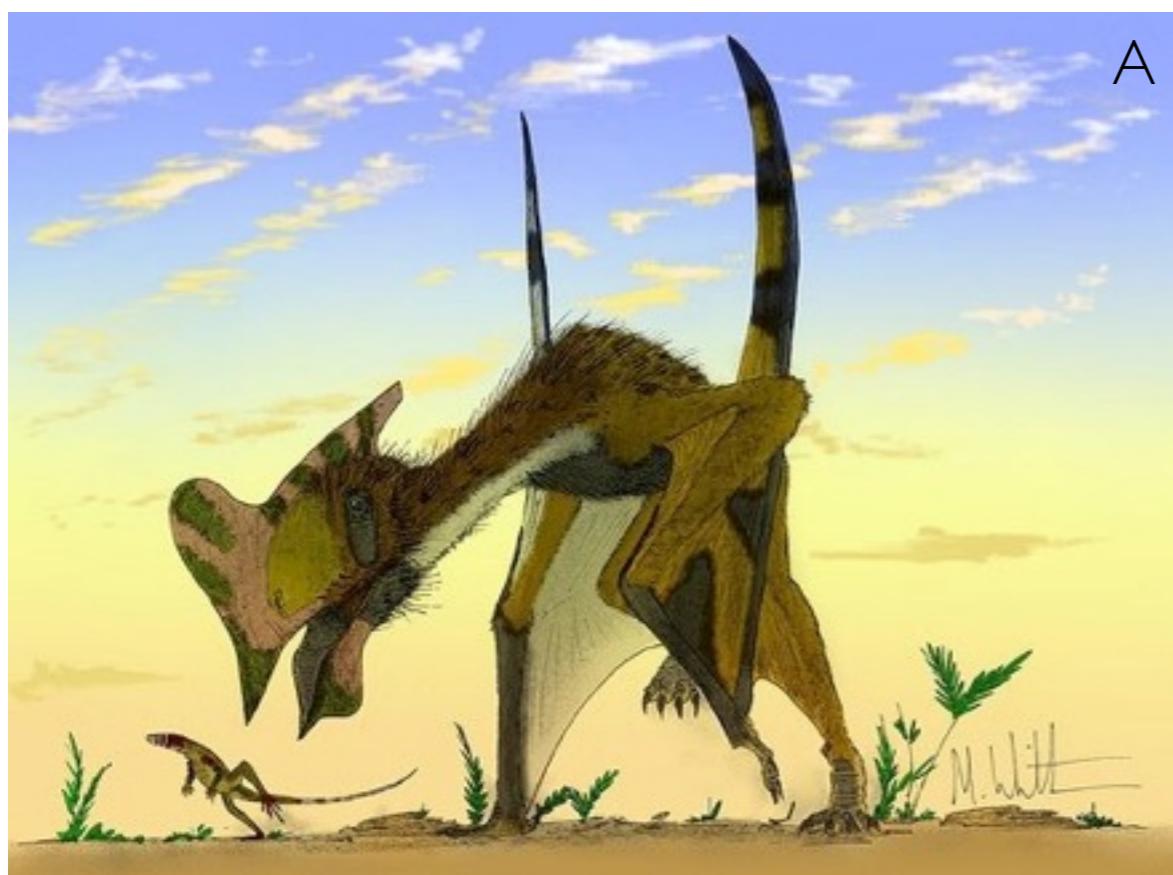


Still a source of contention!

Pterosaur Walking



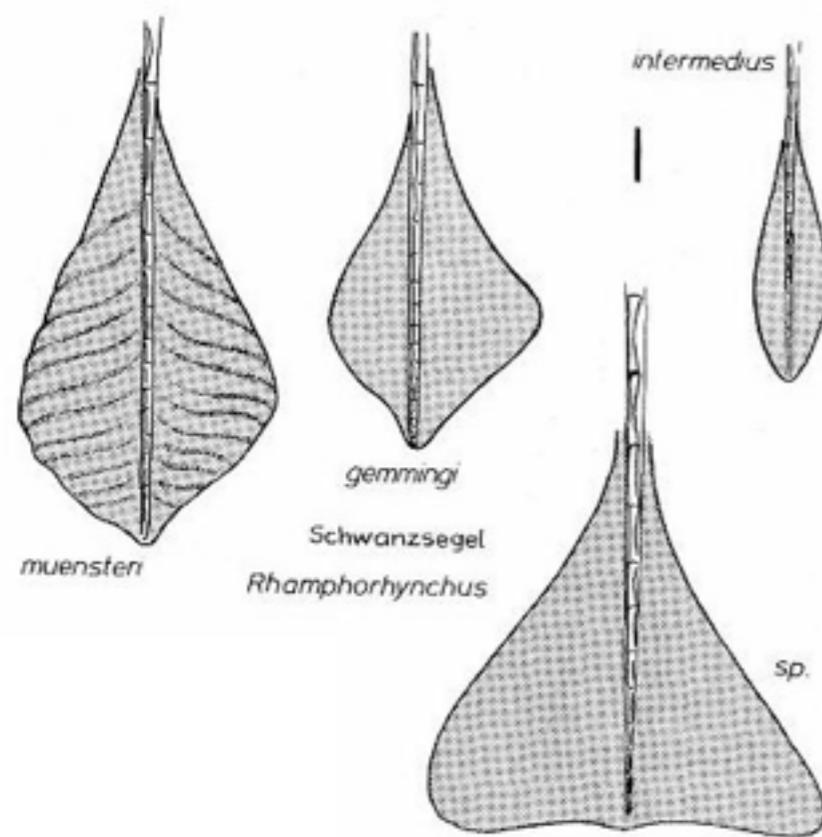
Top: Pteraichnus
Bottom: Running Caiman



Tail Vanes



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



Unique Flight Adaptations in Pterosaurs



Laser Beam eyes

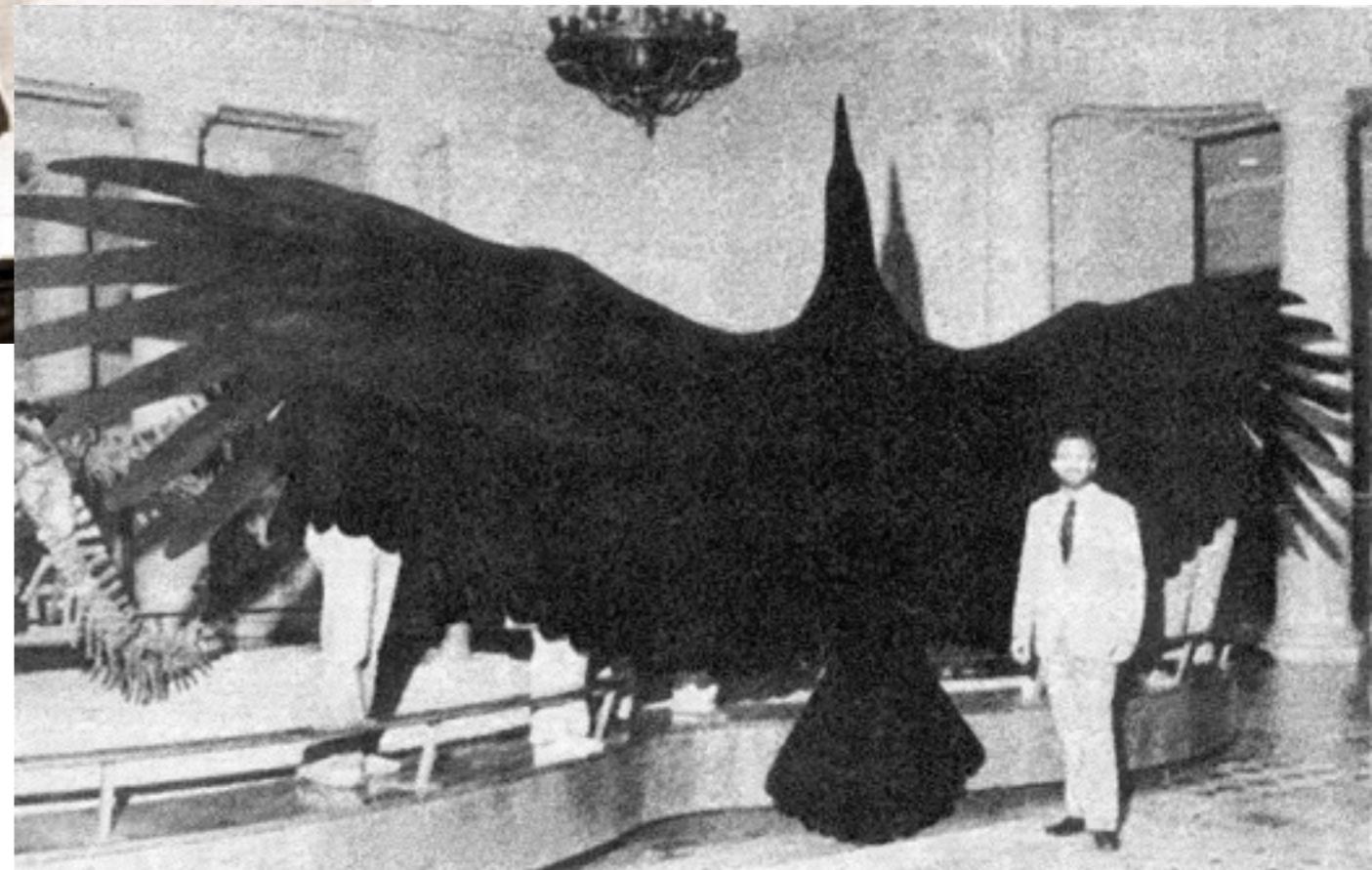
Convergently evolved in Kryptonian humanoids



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

