

Origin of flight

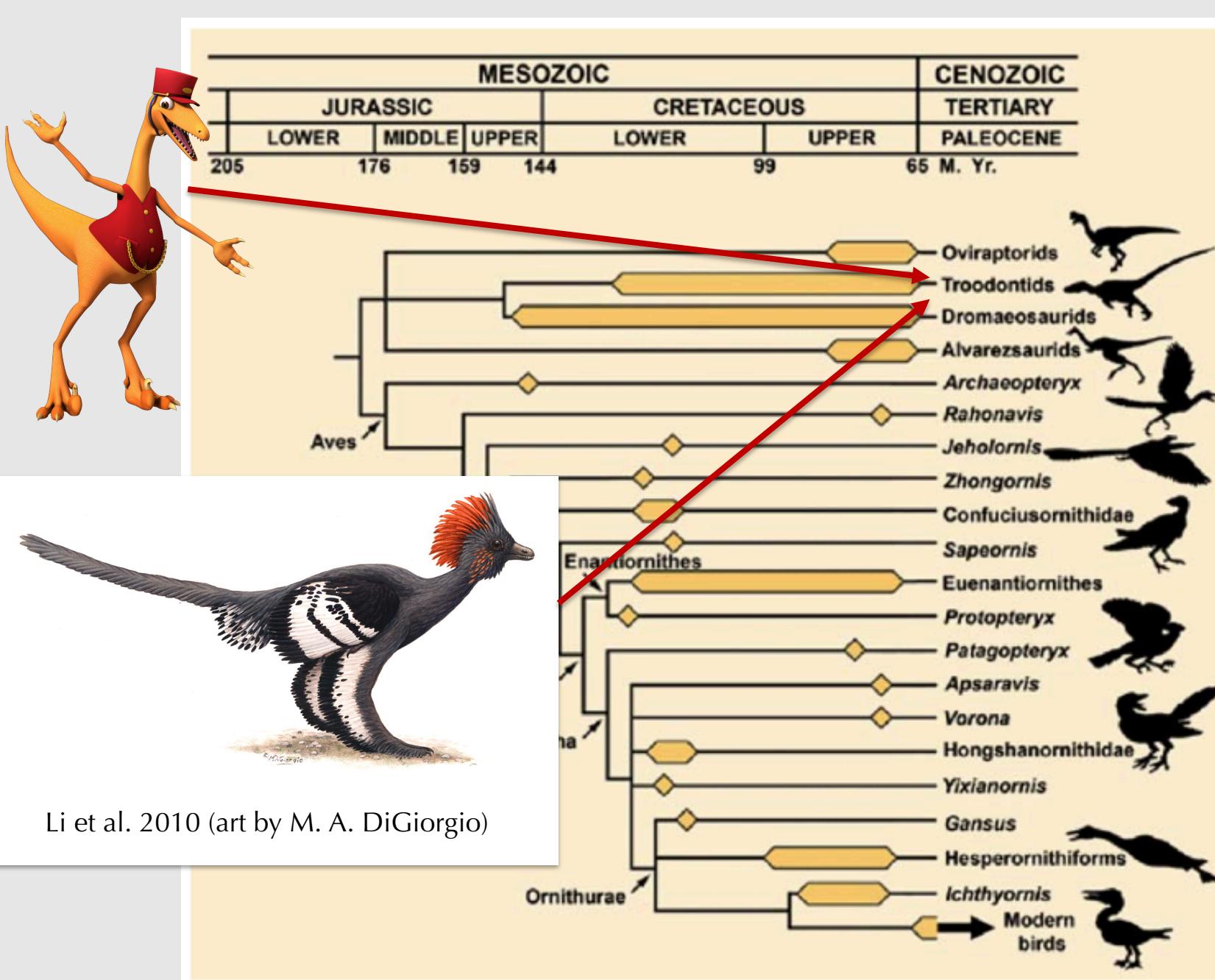


Brian O'Meara
EEB464 Fall 2019

Learning objectives

- Know multiple origins of flight
- Describe hypotheses for origin
- Consider possible evolutionary dead ends





Li et al. 2010 (art by M. A. DiGiorgio)

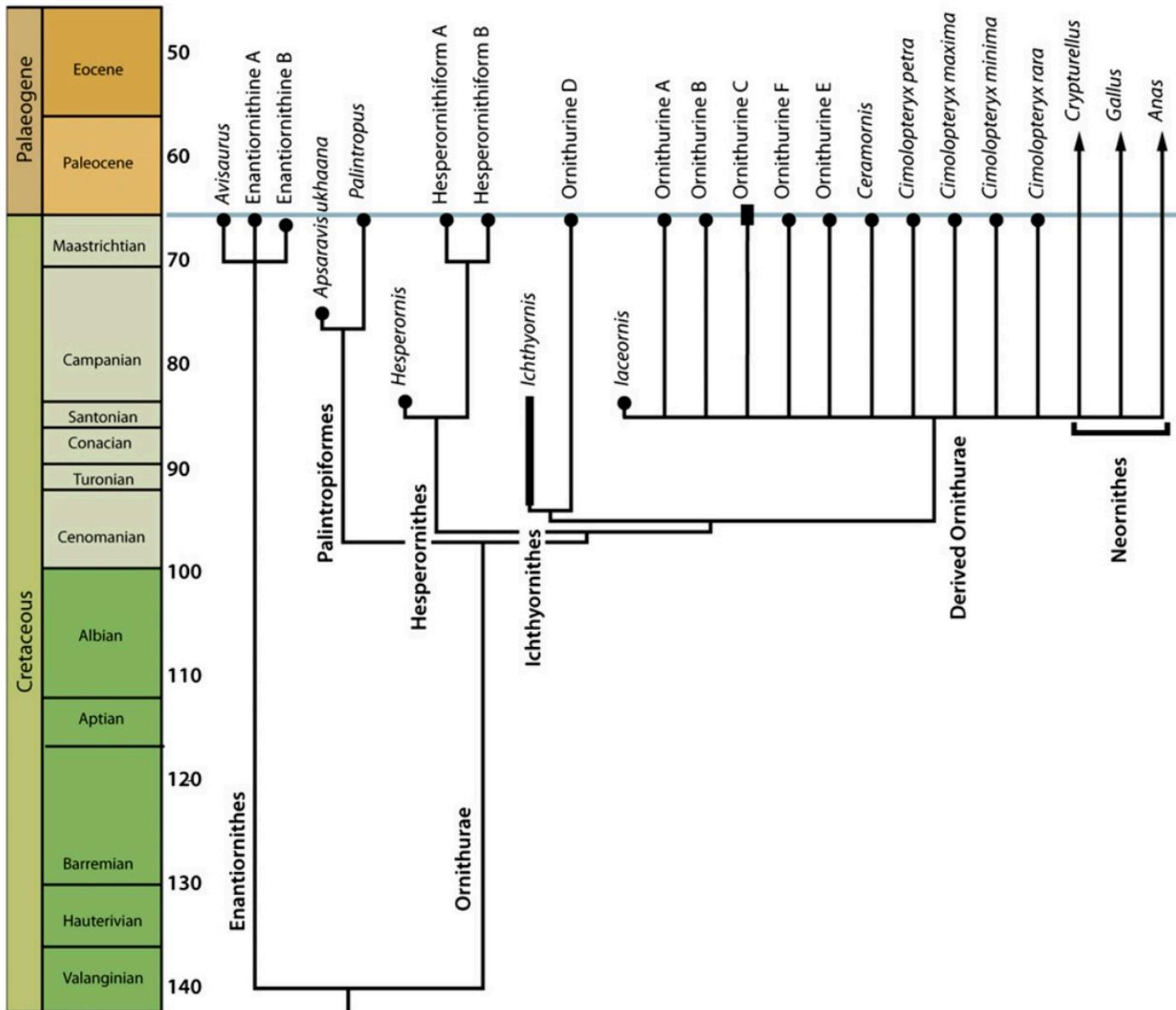
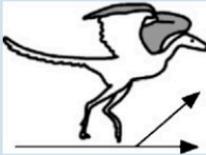
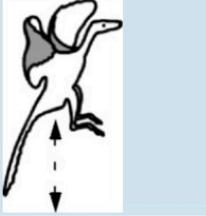
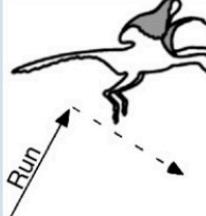
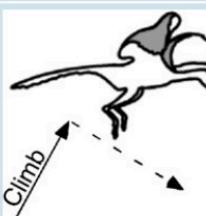
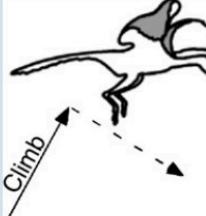
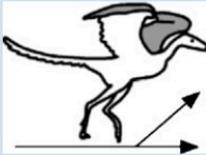
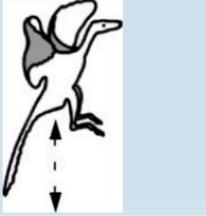
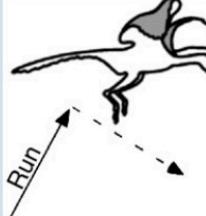
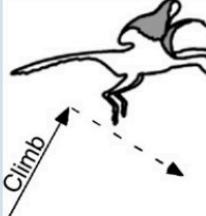


Fig. 4. Phylogeny showing relationships and stratigraphic distribution of late Maastrichtian birds (bold) and other avians. Note that the extension of neornithine branches into the mid Late Cretaceous is the result of an unresolved polytomy; the earliest fossil evidence of Neornithes is Maastrichtian (9). See [SI Appendix](#) for full results and details of the analysis.

A		B			C	
Hypothesis		Behavioral context of incipient wings			Proposed behavior observed in extant tetrapods?	Extant support for inferred form–function relationships?
			Role of hindlimbs	Role of forelimbs		
Wing-assisted incline running (WAIR, OTW)	[1,2]		Run	Flap	Yes: many birds No: birds do not flap to run faster	[1,47–49] No
Thrust generation for faster running	[3–6]					
Running on water (Jesus-Christ lizard)	[7,8]				Yes: basilisk lizards (but do not flap), aquatic birds (takeoff, usually)	[8,50]
Leaping biped	[9,10]		Run and jump	Flap	No	No
Insect net	[11,12]			Flap, acquire prey	Yes/No: some bats, but not while running and jumping	[51]
Predatory strike	[13–15]				Yes: mammalian felids jump and swipe, but not birds or reptiles	No
Wings for stability	[16,17]			Glide	No	No
Running into headwind	[18]				No	No
Intraspecific fighting	[19]		Stand and jump	Flap	Yes: many extant adult birds	No
Jumping model	[20]				Yes: many extant birds during takeoff, display, or predator escape	[20]
Ridge gliding	[21–23]		Run and jump	Glide	Yes: petrels, etc.	[52,53]
Controlled flapping descent (CFD, OTW)	[2]		Run	Flap	Yes: immature birds	[2,54]
Arboreal gliding	[24–44]		Climb, ± jump, ± aerodynamic force	Glide, climb	Yes: <i>Draco</i> , flying squirrels, etc., but not birds	[55,56]
Pouncing predator	[45]		Climb, jump, acquire prey		Yes/No: swooping birds do not climb to elevated ambush sites	No
Flutter-gliding	[46]		Climb	Glide, flap, climb	Yes/No: immature birds climb but do not glide	No

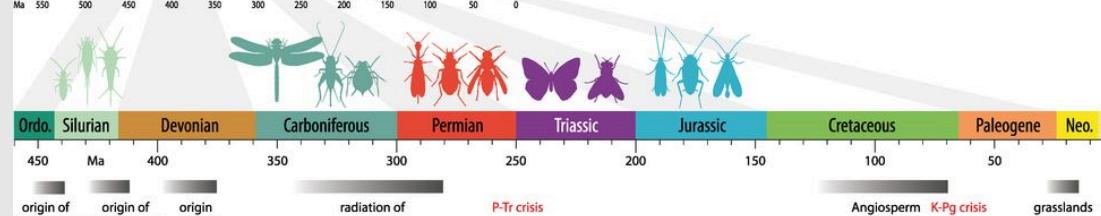
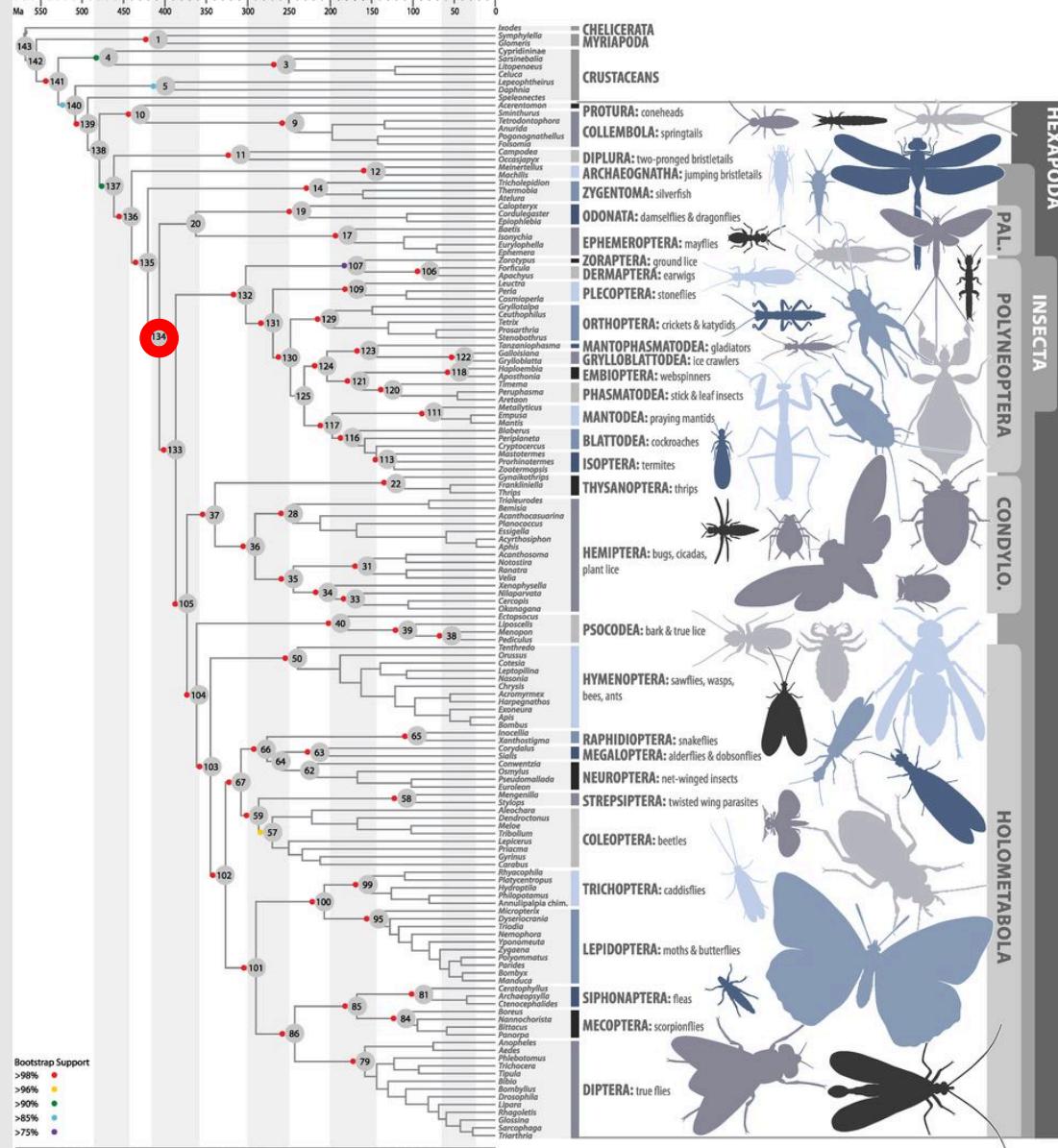


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duncantakeru:<https://www.youtube.com/watch?v=Yk4ZN1A6E0M>

The origins of winged (pterygote) insects are both **unresolved** and **deeply puzzling**, given the absence of transitional fossil forms. Flying insects probably evolved in either the Upper Devonian or early Lower Carboniferous, and by the onset of the Upper Carboniferous (~325 Mya) were well diversified into about fifteen orders, many of which resemble taxa existing today (Grimaldi and Engel 2005). Fossils of these late Paleozoic winged insects and those of ancestrally wingless hexapods at ~390 Mya are separated by approximately 65 million years for which no apterygote, pterygote, or transitional fossil is recorded. The morphological origins of wings and their subsequent elaboration thus remain obscure; pterygote wings are not homologous with the legs (as is the case for volant vertebrates), and accordingly represent true evolutionary novelty.



(a)



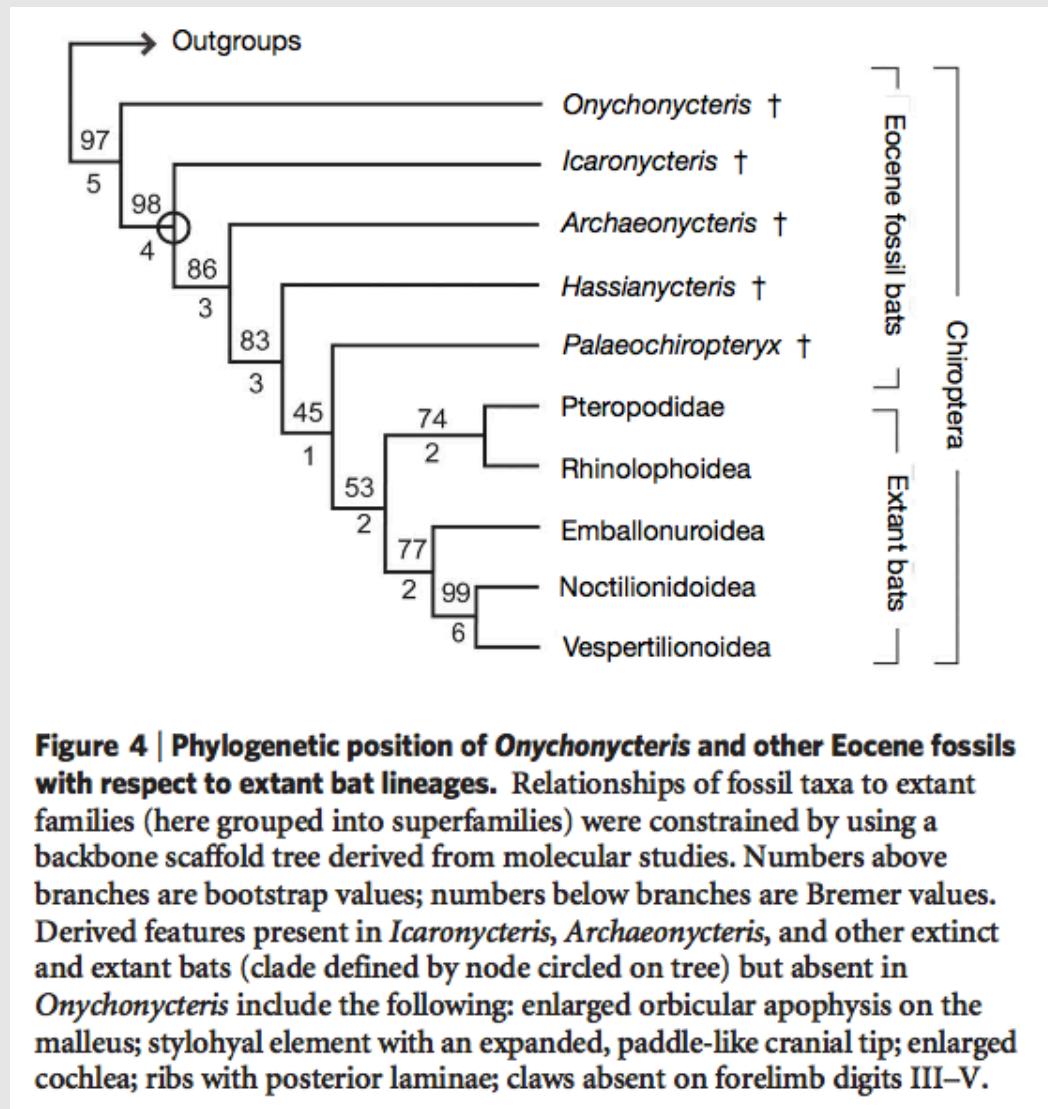
(b)



Fig. 1. (a) Female stonefly (*Allocapnia* spp.) in sailing position on the water surface, showing the spinnaker-like arrangement of the wings. (b) Male stonefly sailing. The males of some species have much shorter wings than the females and are unable to fly (or even flap). Instead they use their wings to sail across the water surface. *Drawings based on a series of photographs by Marden and Kramer².*



Yanoviak et al. Gliding hexapods and the origins of insect aerial behaviour. Biology Letters (2009) vol. 5 (4) pp. 510



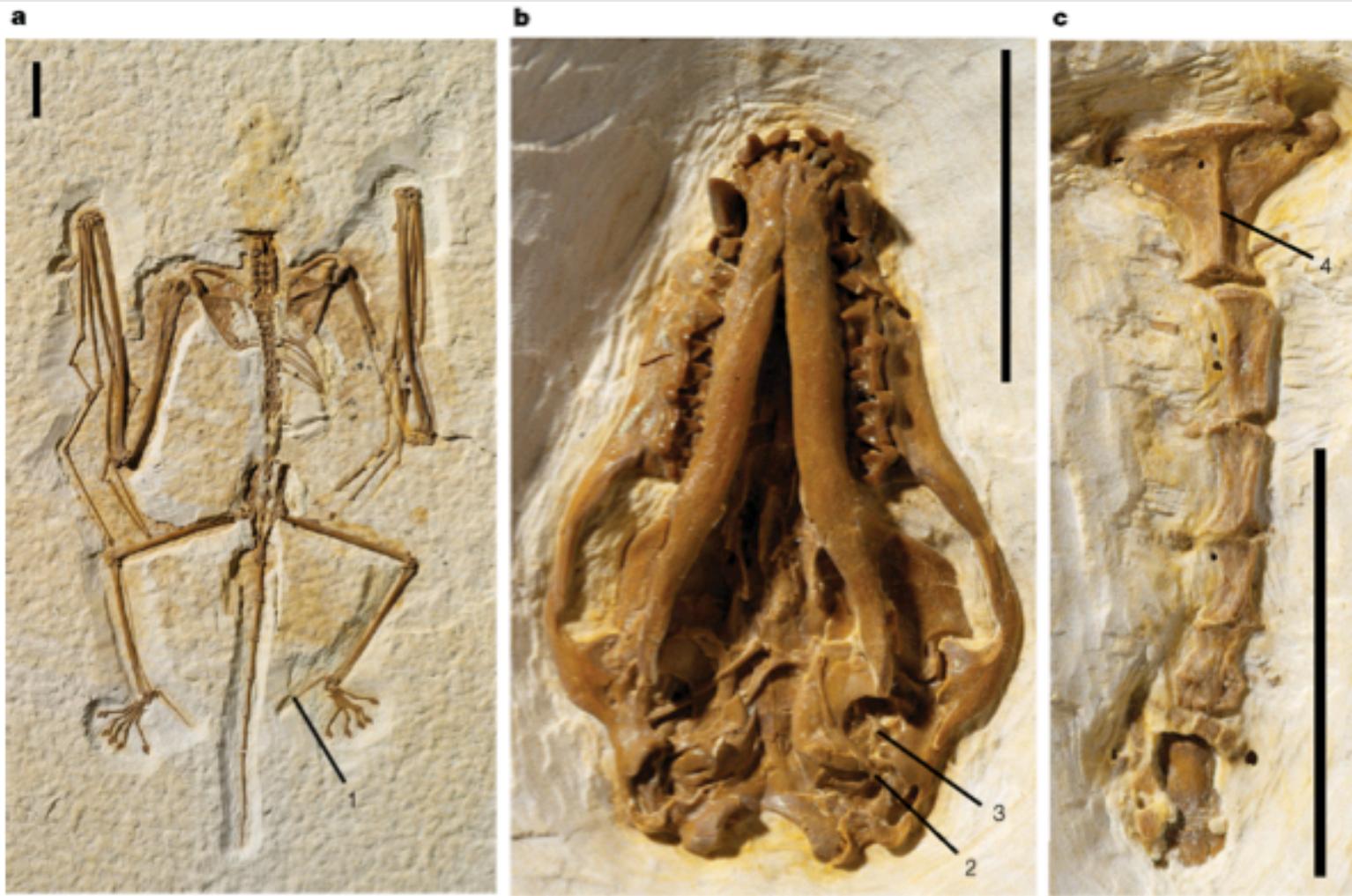
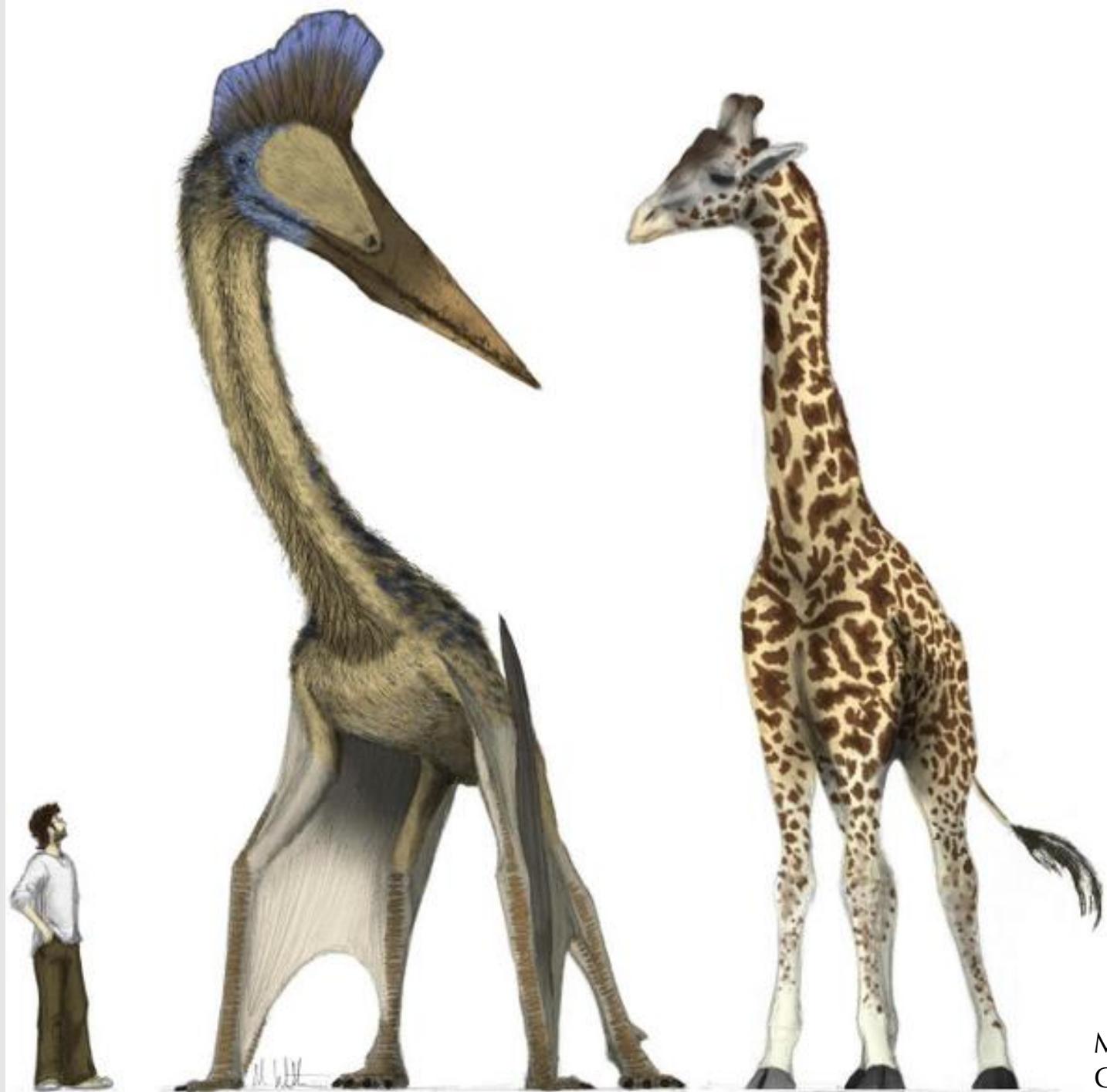


Figure 1 | Holotype of *Onychonycteris finneyi* (ROM 55351A). a, Skeleton in dorsal view. b, Skull in ventral view. c, Sternum in ventral view. Scale bars, 1 cm. All elements are preserved on a single slab with the skeleton exposed on one side, and the skull and sternum on the reverse. The counter-part slab

(ROM 55351B, not shown) preserves impressions of parts of the dorsal aspect of the skeleton. Features labelled: 1, calcar; 2, cranial tip of stylohyal; 3, orbicular apophysis of malleus; 4, keel on manubrium of sternum.

Forelimb anatomy indicates that the new bat was capable of powered flight like other Eocene bats, but ear morphology suggests that it lacked their echolocation abilities, supporting a ‘flight first’ hypothesis for chiropteran evolution. The shape of the wings suggests that an undulating gliding–fluttering flight style may be primitive for bats, and the presence of a long calcar indicates that a broad tail membrane evolved early in Chiroptera, probably functioning as an additional airfoil rather than as a prey- capture device. Limb proportions and retention of claws on all digits indicate that the new bat may have been an agile climber that employed quadrupedal locomotion and under-branch hanging behaviour.



M. Witton via
G. Trivedi

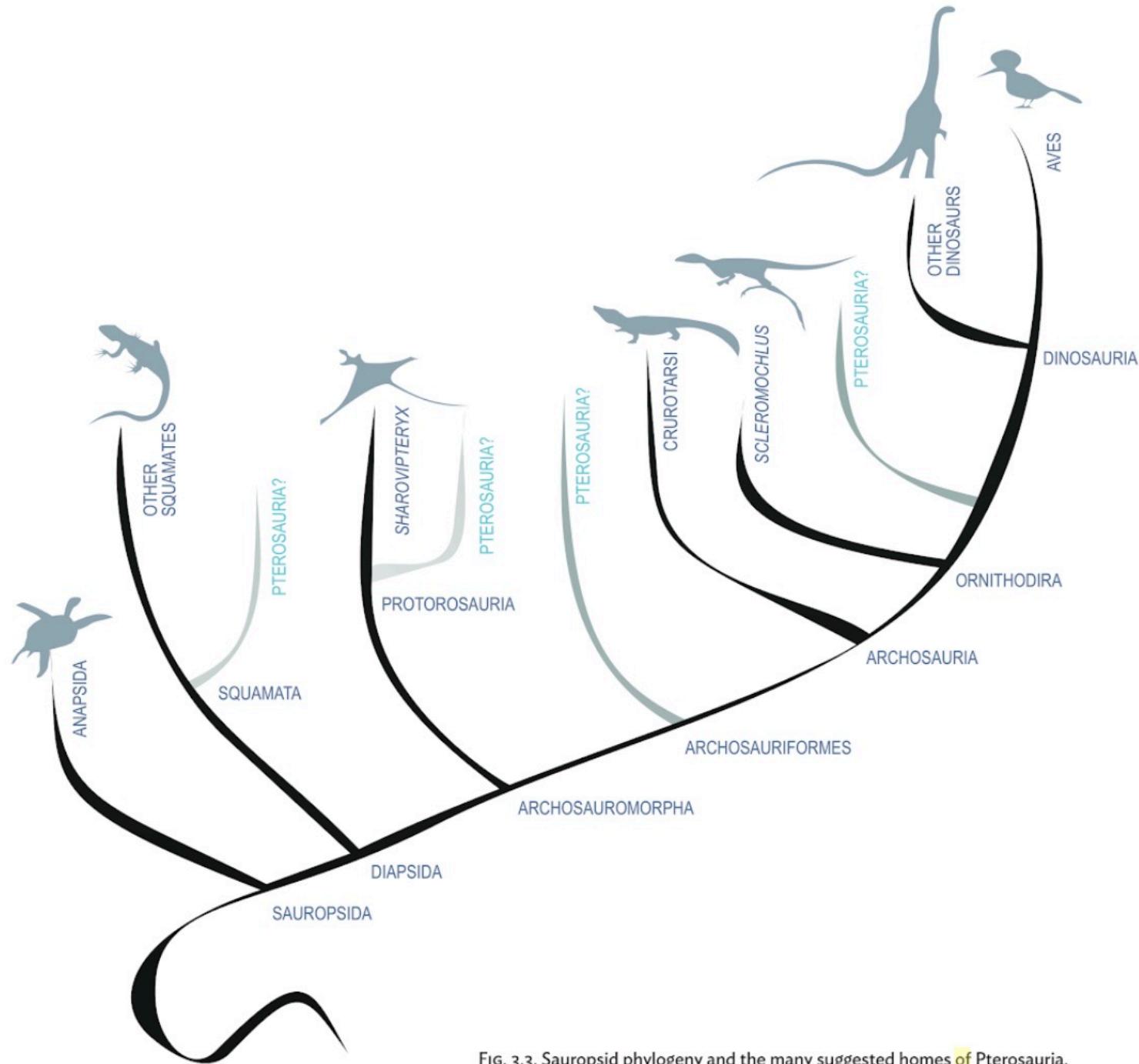


FIG. 3.3. Sauropsid phylogeny and the many suggested homes of Pterosauria.

Almost, or dead end? [gliding]

- Flying fish
- Gliding frogs
- Gliding snakes
- Gliding worker ants
- Flying squid
- Flying squirrels
- Plant adaptations (maple seeds, dandelions, etc.)



<http://www.youtube.com/watch?v=RLbkVanjHVU>



http://www.youtube.com/watch?v=UCSf5_894B4



<http://www.youtube.com/watch?v=8nEwte-x-iw>