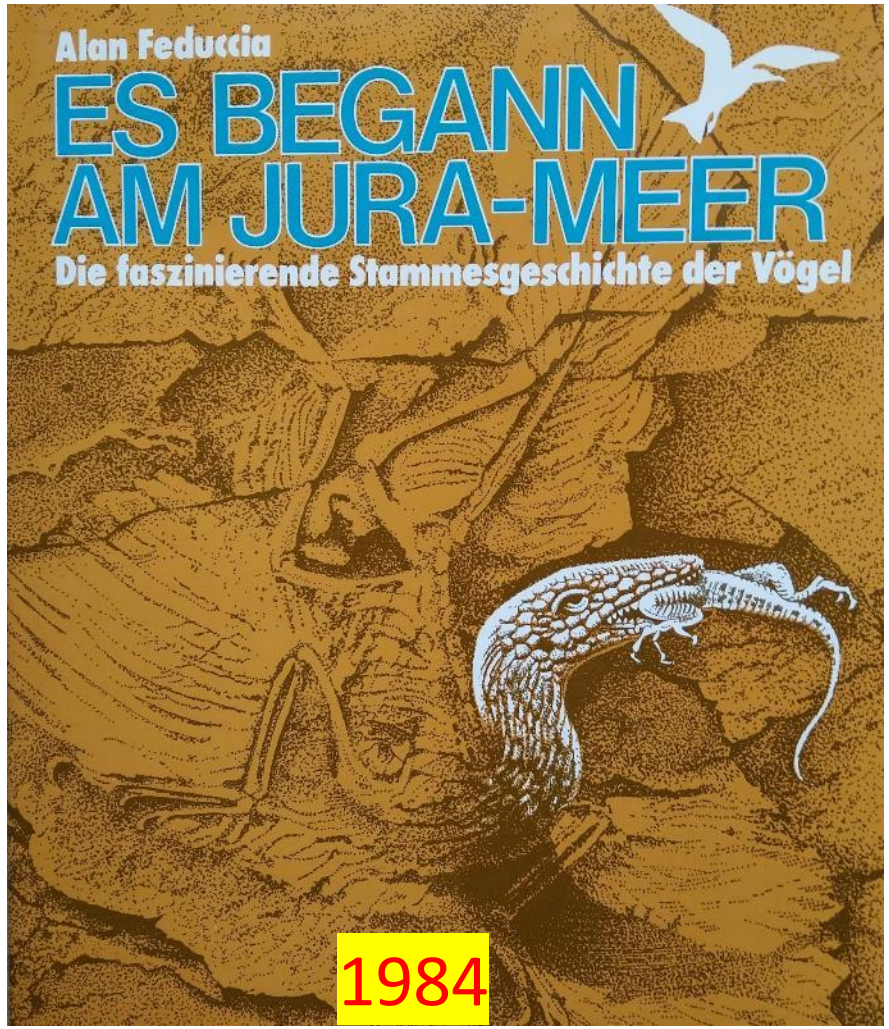
Gefiederte Dinosaurier

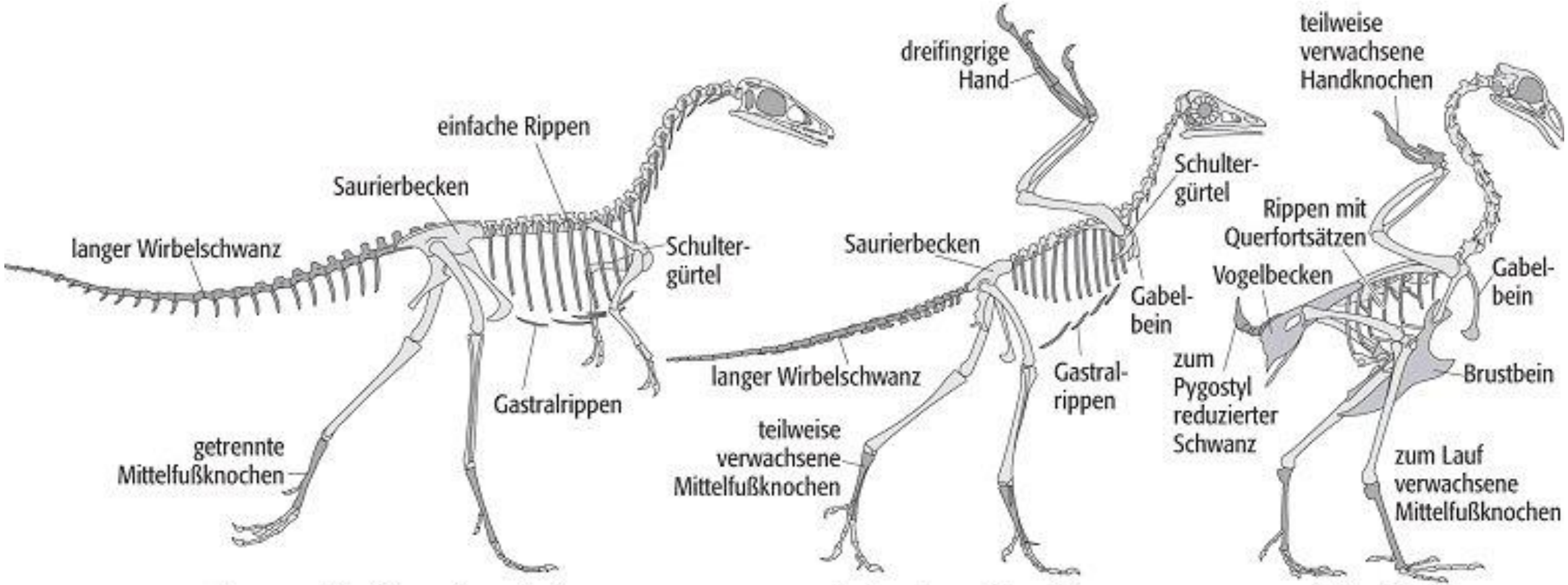
Evolution und (neue) Systematik der Vögel der Welt

Beat Wartmann

AGEO


Alan Feduccia
ES BEGANN
AM JURA-MEER
Die faszinierende Stammesgeschichte der Vögel
1984

Archaeopteryx lithographica 1861

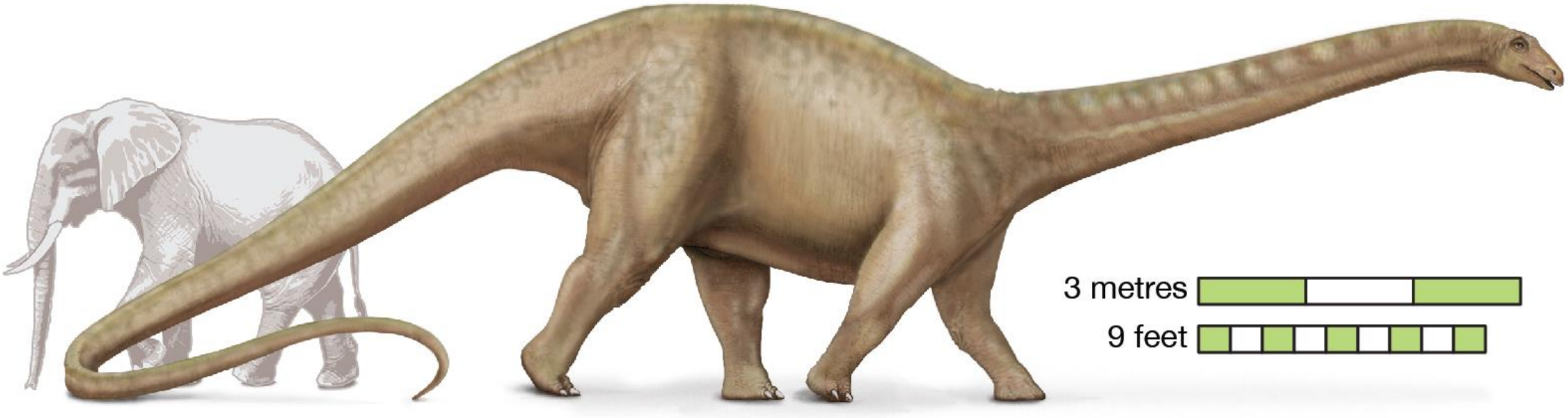


Compsognathus (Zwergdinosaurier) *Archaeopteryx* (Urvogel) *Gallus* (Huhn)

Dinosaurier als kaltblütige Reptilien

Stegosaurus

Brontosaurus
66 feet (20.1 metres) from head to tail
estimated weight: 28.1–34.5 metric-ton range



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66 MYA

Das grosse Sterben

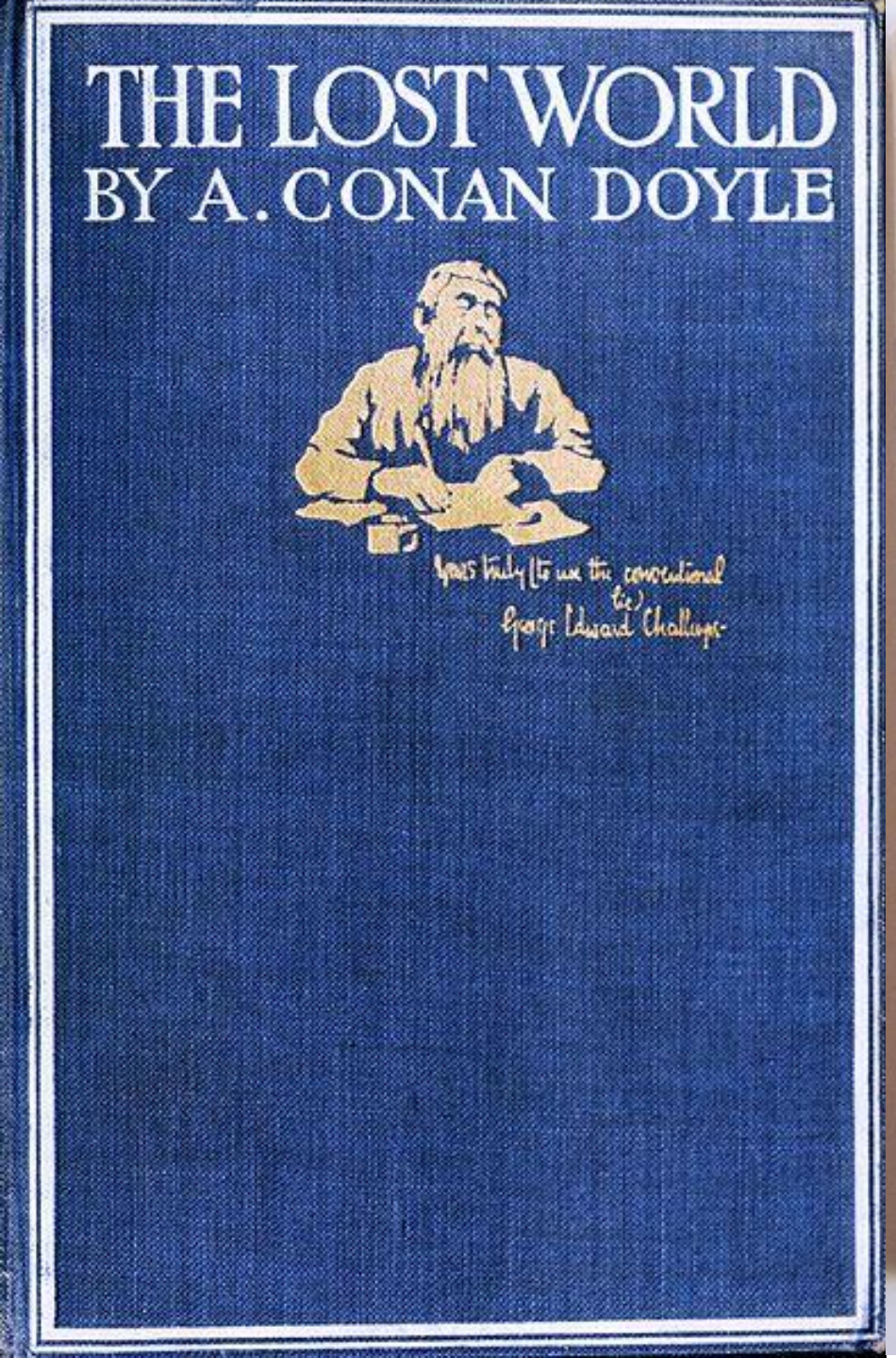
Alle Dinosaurier und etwa 50 % aller Gattungen wurden ausgelöscht durch Meteoriteinschlag

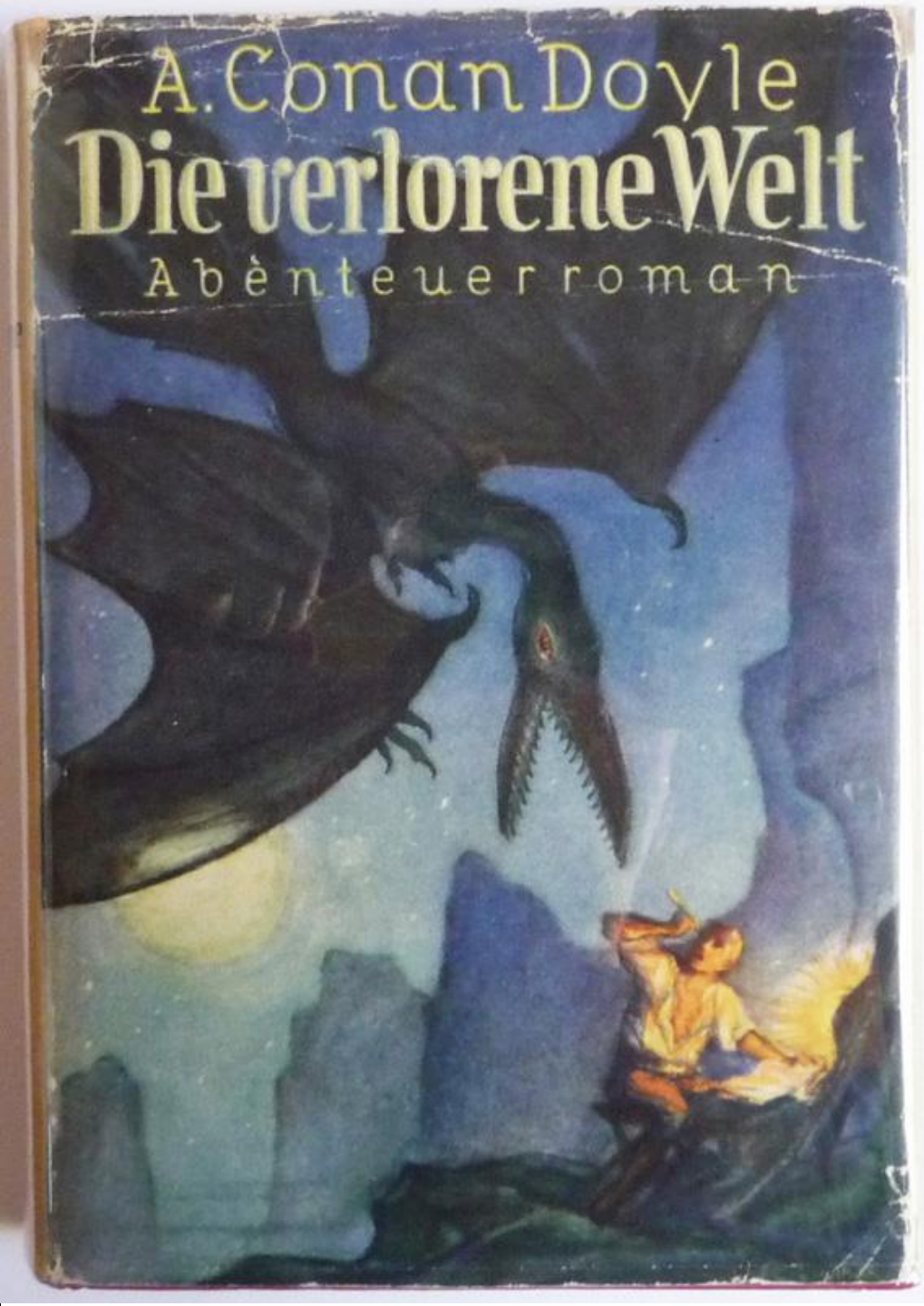
- Tsunamis
- Feuersbrünste
- Nuklearer Winter

Vulkanismus

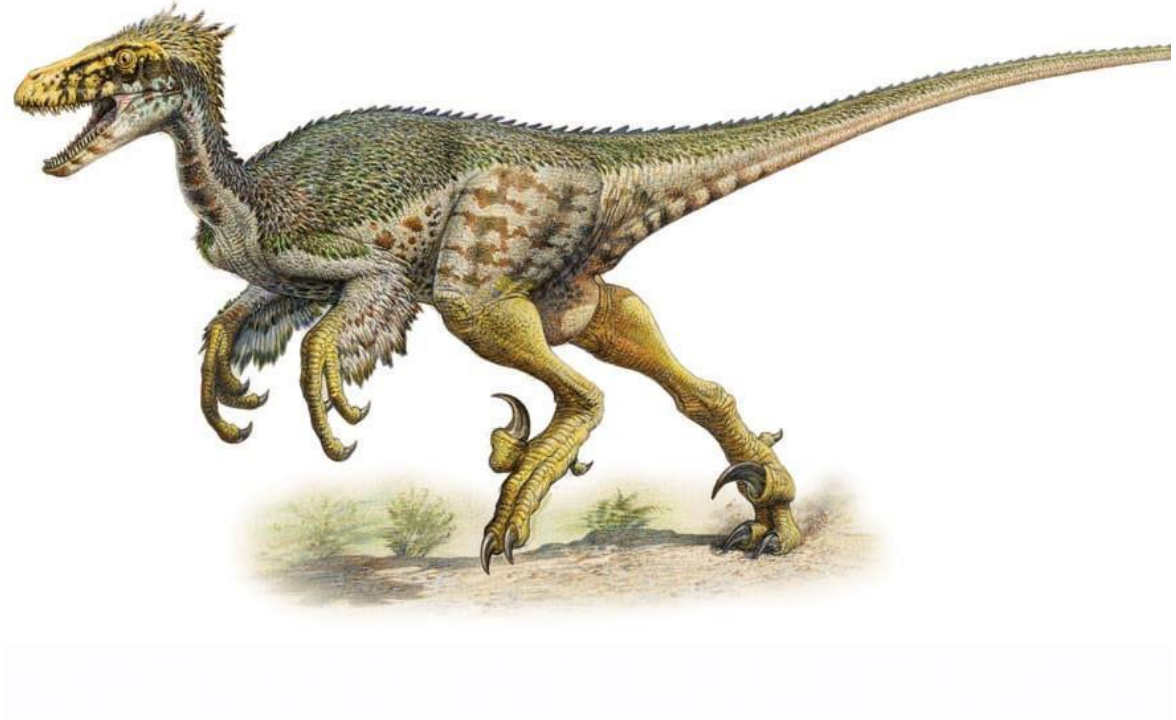
- Klimaänderung

Chicxulub-Krater





Wie Sherlock Holmes gehen wir auf die Suche nach überlebenden Dinosauriern



Warmblütige Dinosaurier

- 1969
- John Ostrom entdeckt Deinonychus, einen flinken Fleischfresser, der seine Beute jagt und mit den scharfen Klauen tötet

Nature, 8 January 1998

articles

An exceptionally well-preserved theropod dinosaur from the Yixian Formation of China

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† *Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica, PO Box 643, Beijing 100044, People's Republic of China*
‡ *Beijing Natural History Museum, 126 Tien Qiao Street, Beijing 100050, People's Republic of China*

Publishers Ltd 1998

Two spectacular fossilized dinosaur skeletons were recently discovered in Liaoning in northeastern China. Here we describe the two nearly complete skeletons of a small theropod that represent a species closely related to *Compsognathus*. *Sinosauropteryx* has the longest tail of any known theropod, and a three-fingered hand dominated by the first finger, which is longer and thicker than either of the bones of the forearm. Both specimens have interesting integumentary structures that could provide information about the origin of feathers. The larger individual also has stomach contents, and a pair of eggs in the abdomen.

The Jehol biota[1] was widely distributed in eastern Asia during latest Jurassic and Early Cretaceous times. These freshwater and terrestrial fossils include macroplants, palynomorphs, charophytes, flagellates, conchostracans, ostracods, shrimps, insects, bivalves, gastropods, breccia, agglomerates and basalts, but has four fossil-bearing sedimentary intercalations that are rich in tuffaceous materials. The Jianshangou (formerly Jianshan[5,6]) intercalated bed (60 m thick) is the basal part of this volcanic sedimentary formation.

Highlights

Walking among dinosaurs

By Dan Chinoy (China Daily)
Updated: 2009-11-24 10:00

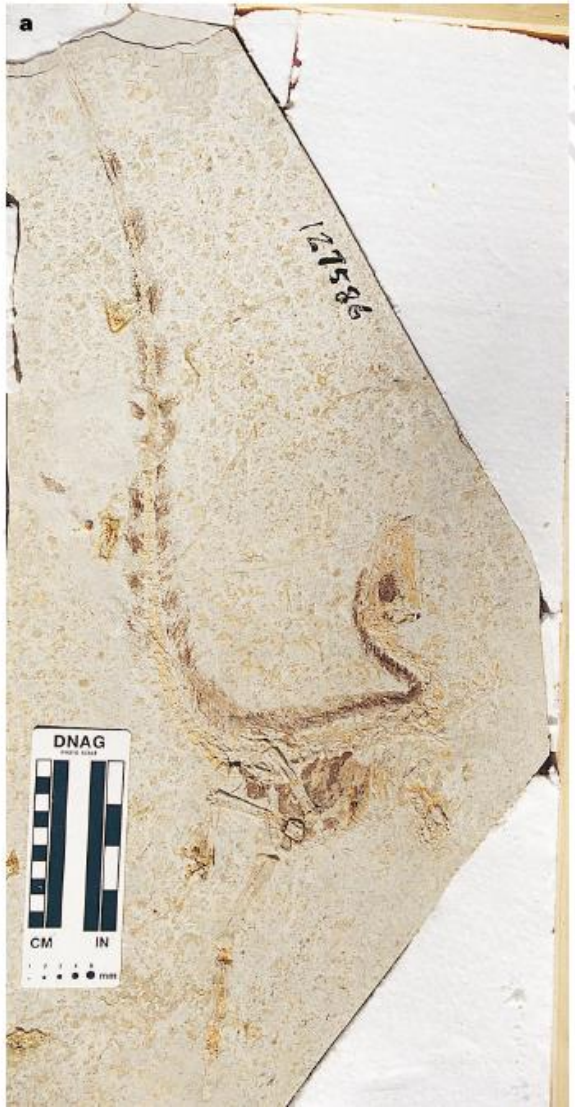
Sihetun is a nondescript village tucked into the dusty brown hills of western Liaoning province, in almost every respect indistinguishable from countless other farming communities of Northeast China. But it was here 13 years ago that Li Yinfang changed the course of science.

Li, a stocky, good-humored farmer with two children, was planting a tree when he noticed something unusual in the ground. With the help of three friends, he carefully unearthed what turned out to be a stunningly well-preserved fossil.

Farmer-turned-dinosaur museum guide Li Yinfang shows the spot where he found the first sinosauropteryx fossil in Sihetun, Liaoning province. [China Daily/Feng Yongbin]

About half a meter in length, the skeleton appeared to have a long tail, strong legs, small arms and a head

Sinosauropteryx prima Ji & Ji



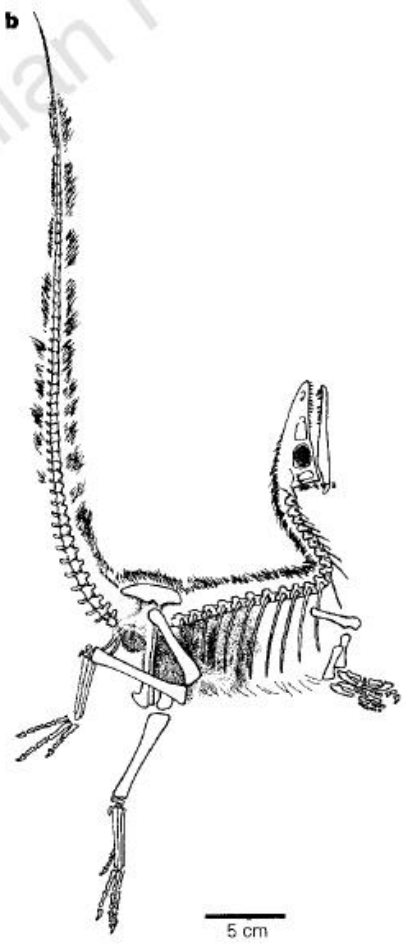
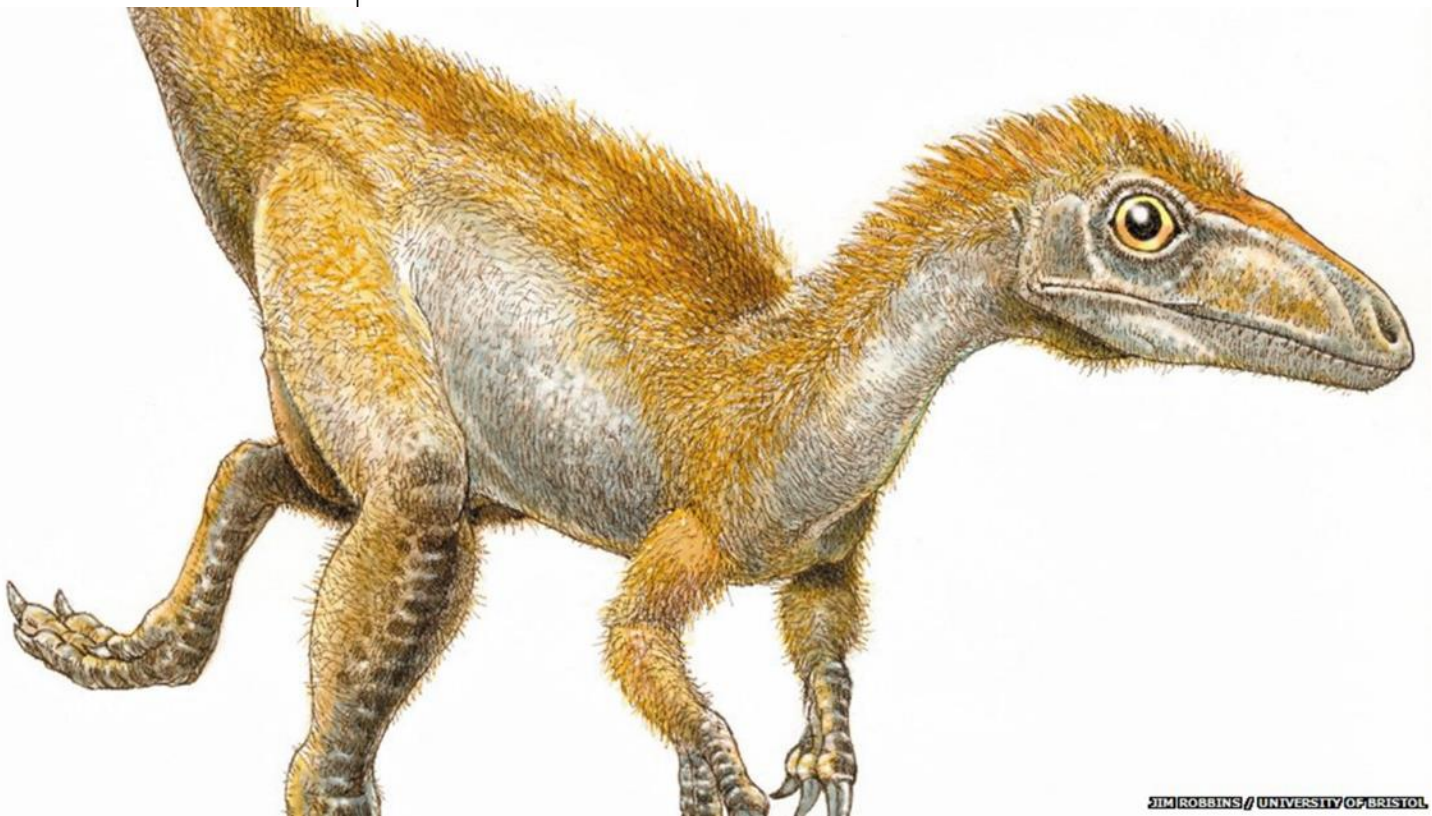
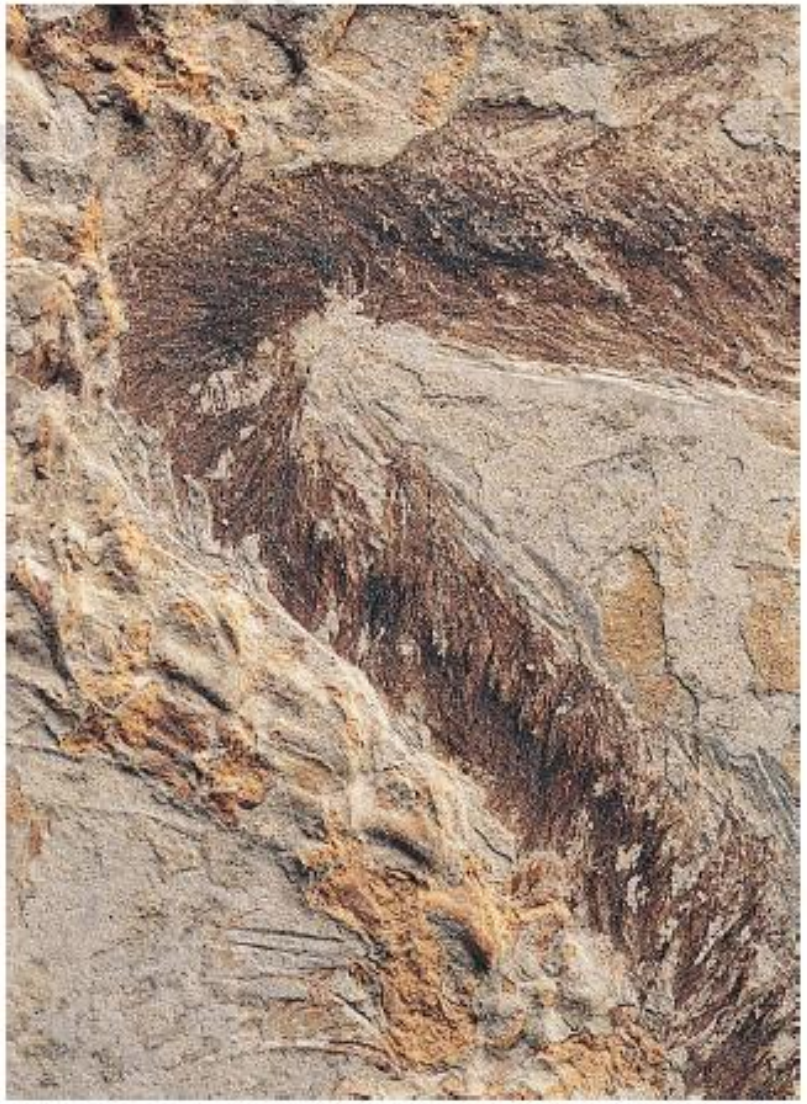


Figure 2 *Sinosauropteryx prima* Ji and Ji. **a**, NIGP 127586, the counterpart of holotype (GMV 2123). **b**, Skeletal reconstruction of NIGP 127586. The integumentary structures are along the dorsal side and tail and dark pigmentation in the abdominal region might be some soft tissues of viscera.



Deutliche Federspuren



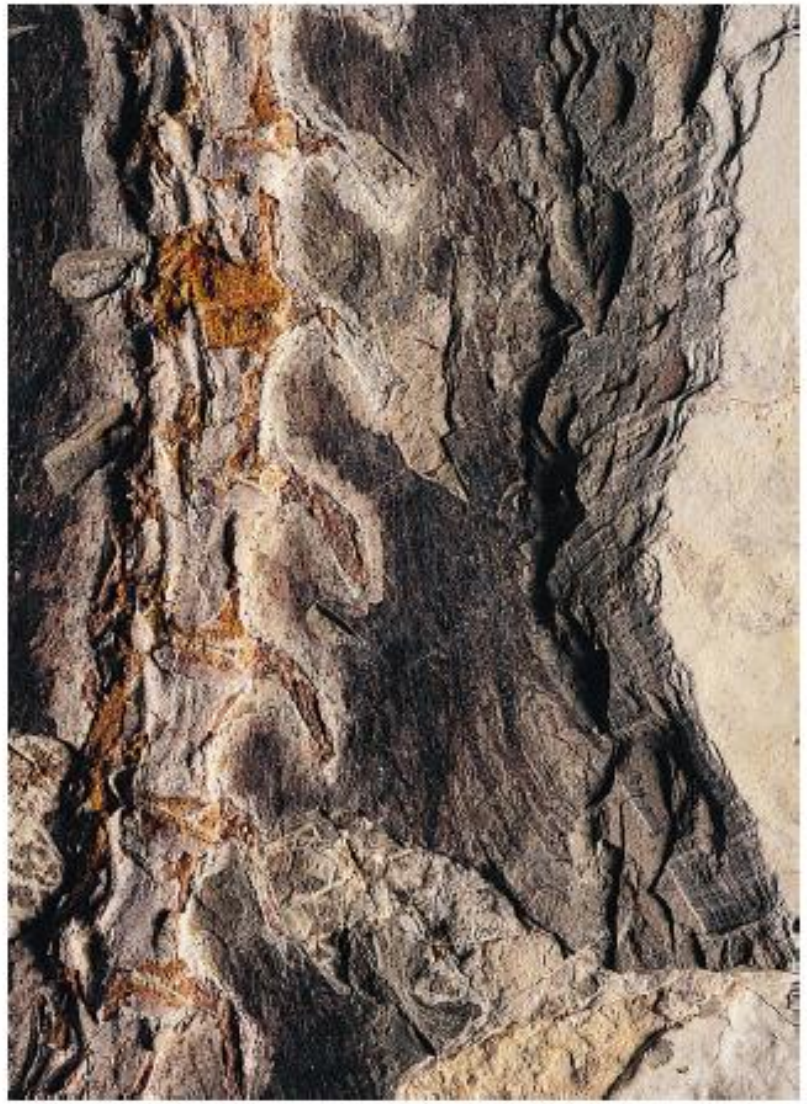


Figure 5 (Far left) Integumentary structures in the neck and dorsal sides of NIGP 127586.

Figure 6 (Left) Integumentary structures over caudal 27 of NIGP 127587.

Nature © Macmillan Publishers Ltd 1998

DINOSAUR HUNTING GROUNDS

Rich deposits of dinosaur fossils are scattered around China. Xing Xu has excavated or studied many of key finds emerging from those sites.

Nature, 25 June 1998

arti

Two feathered dinosaurs from northeastern China

Qiang*, Philip J. Currie†, Mark A. Norell‡ & Ji Shu-An*

National Geological Museum of China, Yangrou Hutong 15, Xisi, 100034 Beijing, People's Republic of China
Royal Tyrrell Museum of Palaeontology, Box 7500, Drumheller, Alberta T0J 0Y0, Canada
American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024-5192, USA

urrent controversy over the origin and early evolution of birds centres on whether or not they are derived fro oelurosaurian theropod dinosaurs. Here we describe two theropods from the Upper Jurassic/Lower Cretace haomidianzi Formation of Liaoning province, China. Although both theropods have feathers, it is likely that n as able to fly. Phylogenetic analysis indicates that they are both more primitive than the earliest known avialar *rchaeopteryx*. These new fossils represent stages in the evolution of birds from feathered, ground-living, bi nosaurs.

Dinosauria Owen 1842
Theropoda Marsh 1881
Maniraptora Gauthier 1986
Unnamed clade
Protarchaeopteryx robusta Ji & Ji 1997

There are two thin, flat, featureless sternal plates. The cla fused into a broad, U-shaped furcula (interclavicular angle 60°) as in *Archaeopteryx*, *Confuciusornis* and many n theropods. The forelimb is shorter than the hindlimb. Th shorter (compared to the femur) than it is in birds, but than those of long-armed non-avian coelurosaurs

Protarchaeopteryx robusta

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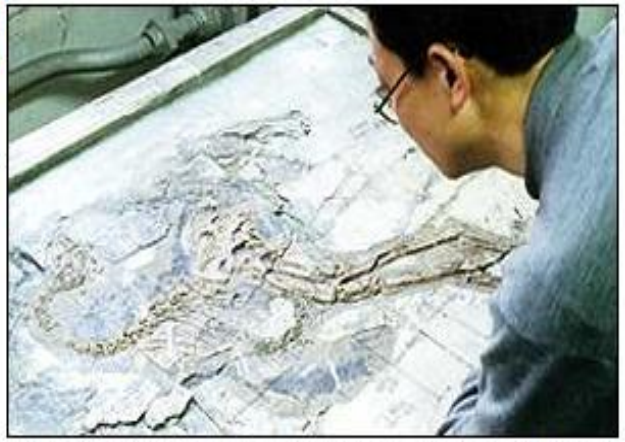
Tuesday, 26 December, 2000, 19:04 GMT

The feathered dinosaurs of Liaoning



The hills of Liaoning have yielded hundreds of fossils

Astonishing fossils are being pulled out of the ground in the remote hills of Liaoning Province, China. The specimens, particularly those of tiny, feathered dinosaurs, are fuelling the debate about the origin of birds. Martin Redfern of BBC Science reports.

Slowly but smoothly, the night train glided north-east from Beijing into Liaoning Province. By six in the morning we had reached the bustling city of Jinzhou from where we continued on a white-knuckle taxi ride, praying that the next corner would not conceal a lorry attempting to overtake a donkey cart on the

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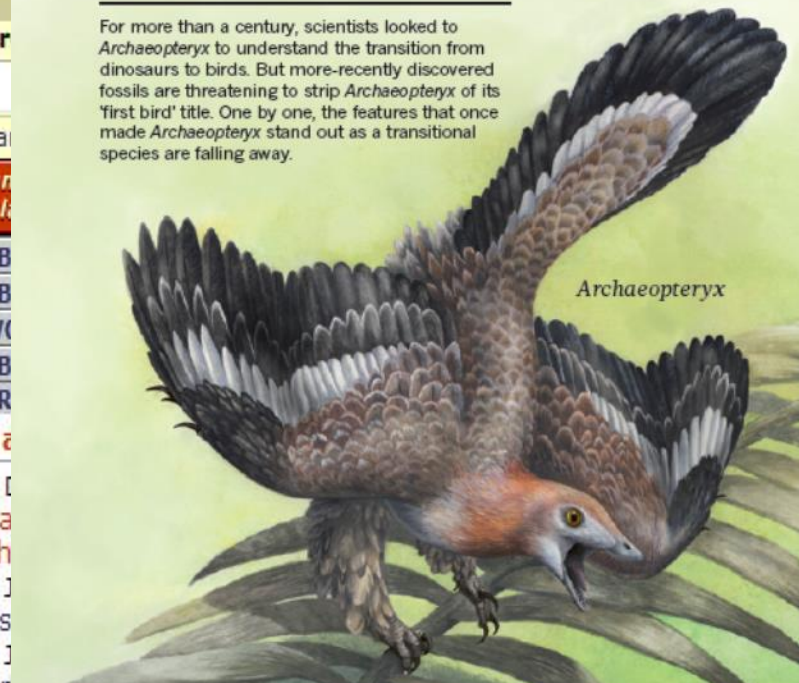
The fight for first bird

For more than a century, scientists looked to *Archaeopteryx* to understand the transition from dinosaurs to birds. But more-recently discovered fossils are threatening to strip *Archaeopteryx* of its 'first bird' title. One by one, the features that once made *Archaeopteryx* stand out as a transitional species are falling away.



Zanabazar junior

Archaeopteryx

Woodpecker

Bird brains for everyone

Despite their reputation, bird brains are big relative to the size of their bodies owing to an expanded cerebrum (red). *Archaeopteryx's* brain was also large, but so were those of other theropod dinosaurs, such as *Zanabazar junior*, suggesting that this trait is not unique to birds.

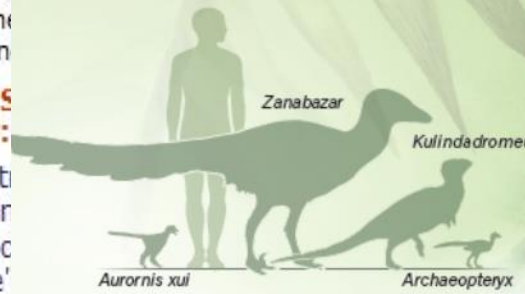
Fossil of forelimb plates and bristles

Fall of feathers

Feathers were once the sign of a bird. Things changed when feathered theropod dinosaurs — from the lineage that gave rise to modern birds — showed up in the 1990s. Now many researchers believe that all dinosaurs had feathers, thanks to *Kulindadromeus zabaikalicus*, which is from a completely different lineage. Its feathers — fossilized as structures that resemble ribbons, plates and bristles — may have been used for warmth or signalling.

Anatomy argument

Aurornis xui is the latest creature to challenge *Archaeopteryx*'s spot as first bird. As well as being of similar size, it has limbs, claws and a tail like *Archaeopteryx*, and it pre-dates its rival by about 10 million years.



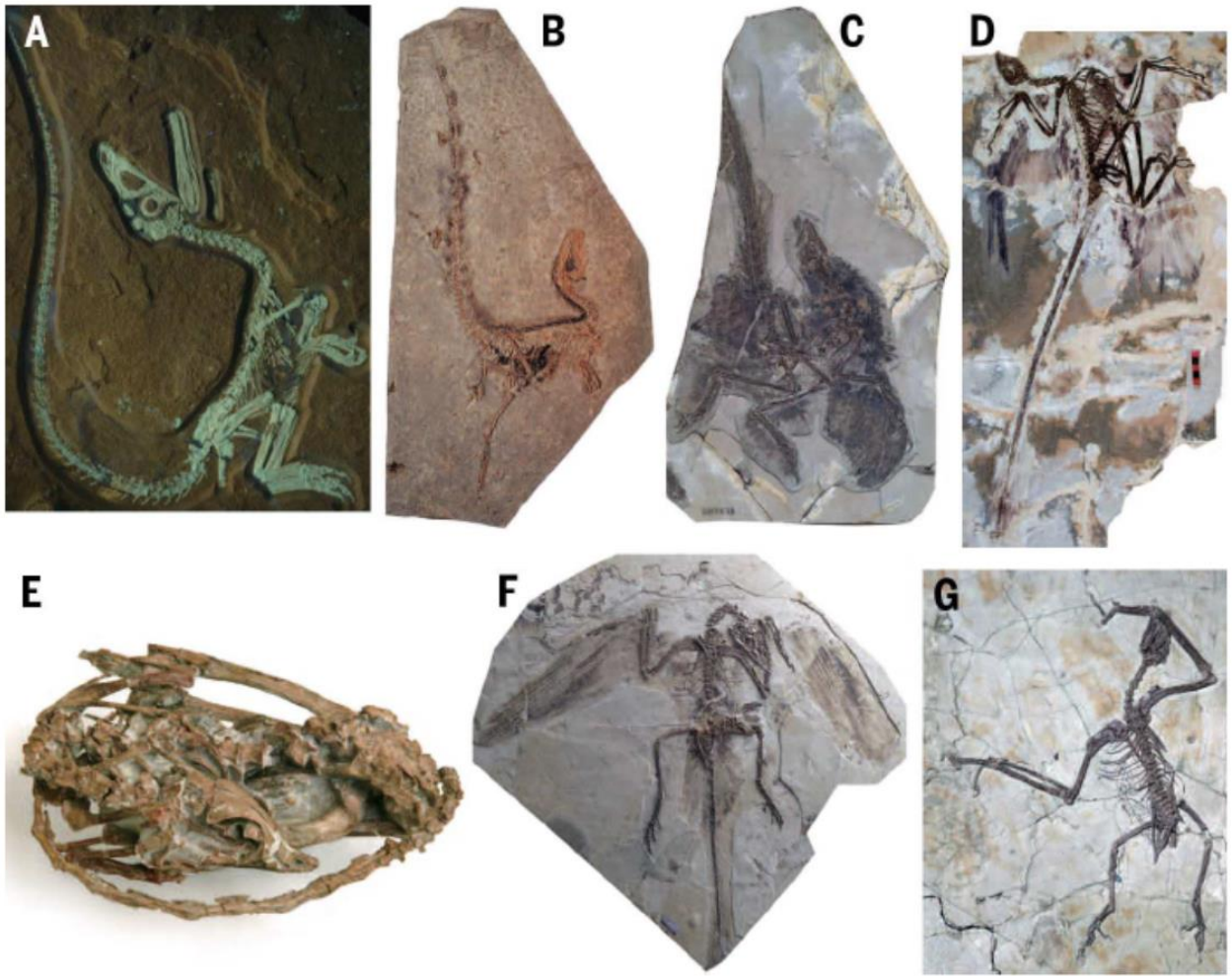
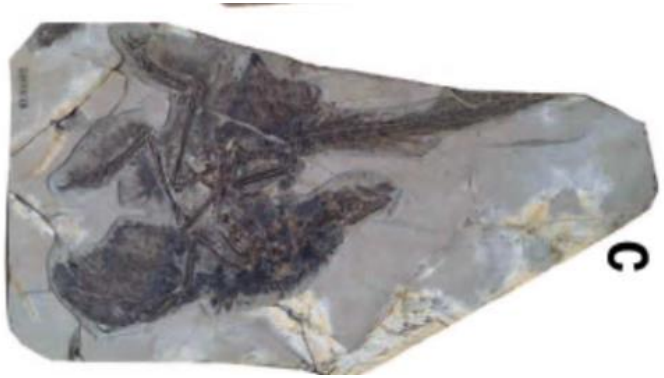


Fig. 1. Selected recently discovered transitional forms of theropods and early birds. The basal tetanuran *Sciurumimus* (**A**) and the basal coelurosaur *Sinosauropteryx* (**B**) with filamentous feathers. The deinonychosaurs *Anchiornis* (**C**) and *Microraptor* (**D**) with numerous skeletal and integumentary features including large vaned feathers on hindlimbs that are also present in basal birds. (**E**) The troodontid *Mei* with a birdlike tuck-in sleeping posture. The basal birds *Jeholornis* with a dromaeosaur-like tail (**F**) and *Sapeornis* with a typical deinonychosaurian shoulder girdle (**G**).


C

Anchiornis
(160 MYA)

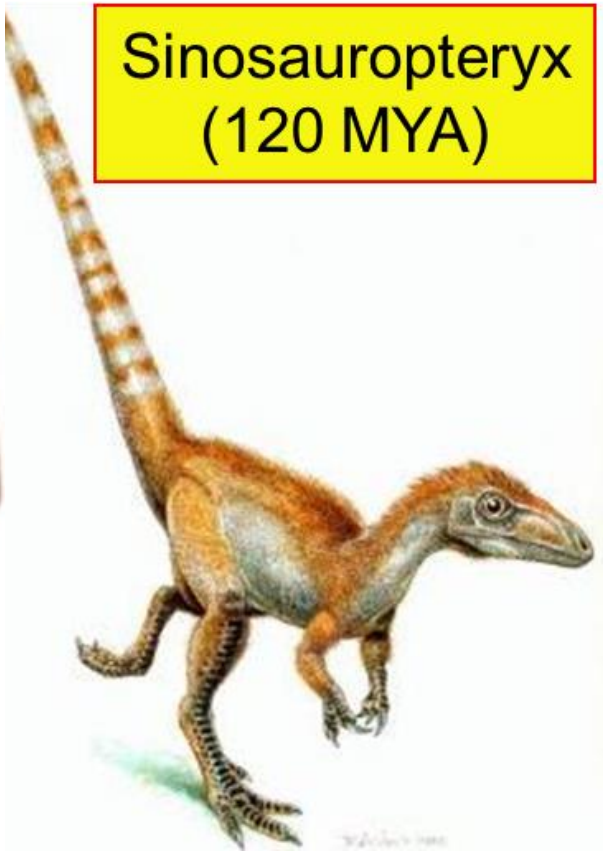
A

Sciurumimus (150 MYA)

E

Mei (130 MYA)

B

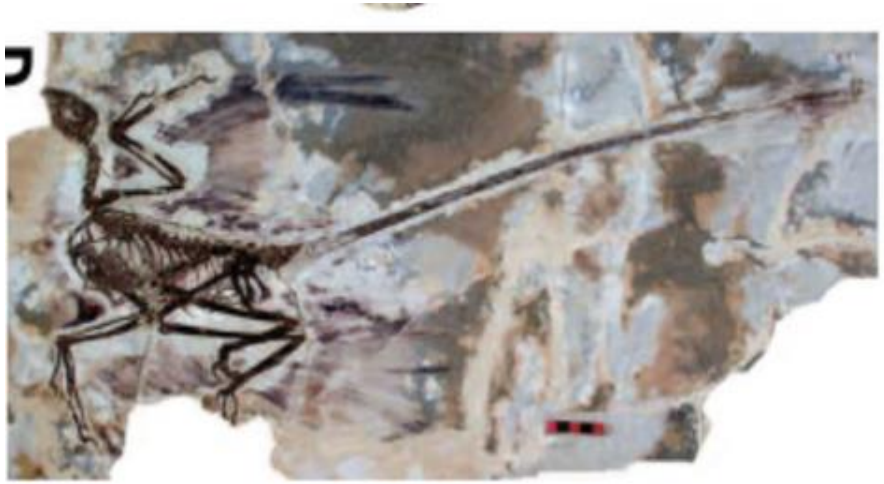

Sinosauropteryx
(120 MYA)

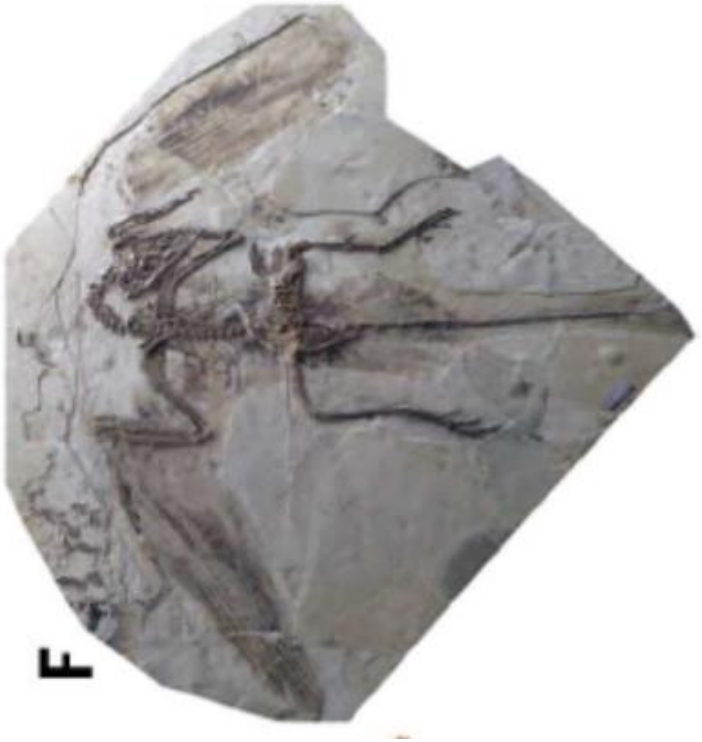
© 2010
Sapeornis
(115 MYA)

Microraptor
(110 MYA)

Jeholornis
(110 MYA)

G




F

Die neue Verwandtschaft von *Tyrannosaurus rex*

Endlich geben Fossilfunde Aufschluss über die lange Evolution der Tyrannosaurier, einen Ast der zweibeinigen, meist Fleisch fressenden Theropoden. Die Gruppe war erstaunlich vielfältig. Aber erst in der letzten Phase entstanden die dominierenden Herrscher über die Tierwelt wie *Tyrannosaurus rex*. Hier ist von den Arten meist nur der (erste) Gattungsname angeführt.

1 *Kileskus*
Die leichtgewichtige Art aus Zentralsibirien sowie *Procerosaurus* aus England sind die ältesten bekannten Tyrannosaurier.

2 *Guanlong*
Der Saurier aus China trug einen auffallenden Scheitelkamm, der zur Balz oder zur Einschüchterung von Rivalen gedient haben könnte.

3 *Yutyrannus*
Die für ihre Zeit recht große Art aus China trug ein dichtes, haariges Federkleid. Also besaßen nicht nur die kleinen Arten Federn.

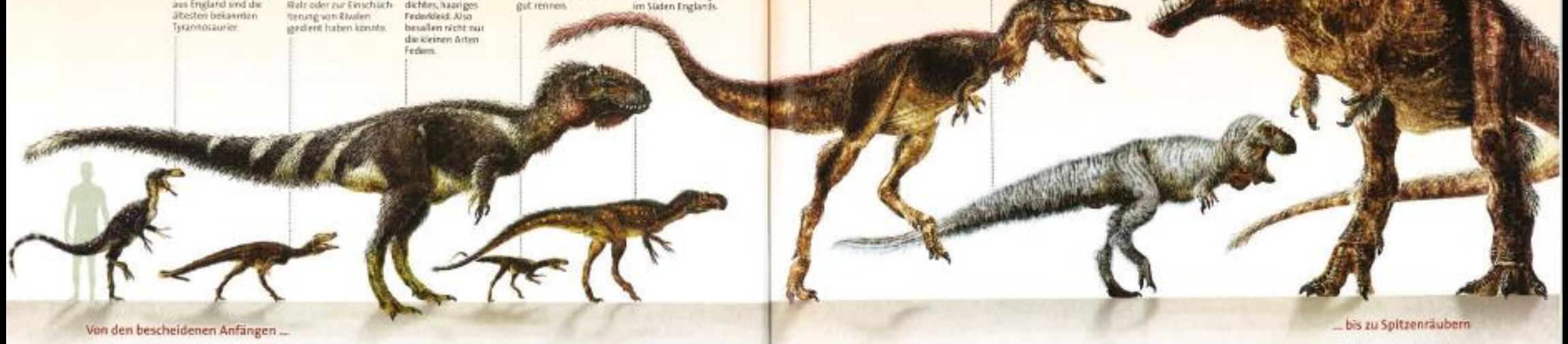
4 *Dilong*
Der kleinste bekannte Tyrannosaurier kommt aus China und konnte gut rennen.

5 *Eotyrannus*
Fossilien dieser langfingrigen Art stammen von der Isle of Wight im Süden Englands.

6 *Qianzhousaurus*
Wegen der ungewöhnlich langen Schnauze des graziilen Tiers aus China sprechen Forscher scherzhaft von Pinocchio rex. Es beweist, dass die Tyrannosaurier nicht nur Muskelkolosse hervorbrachten.

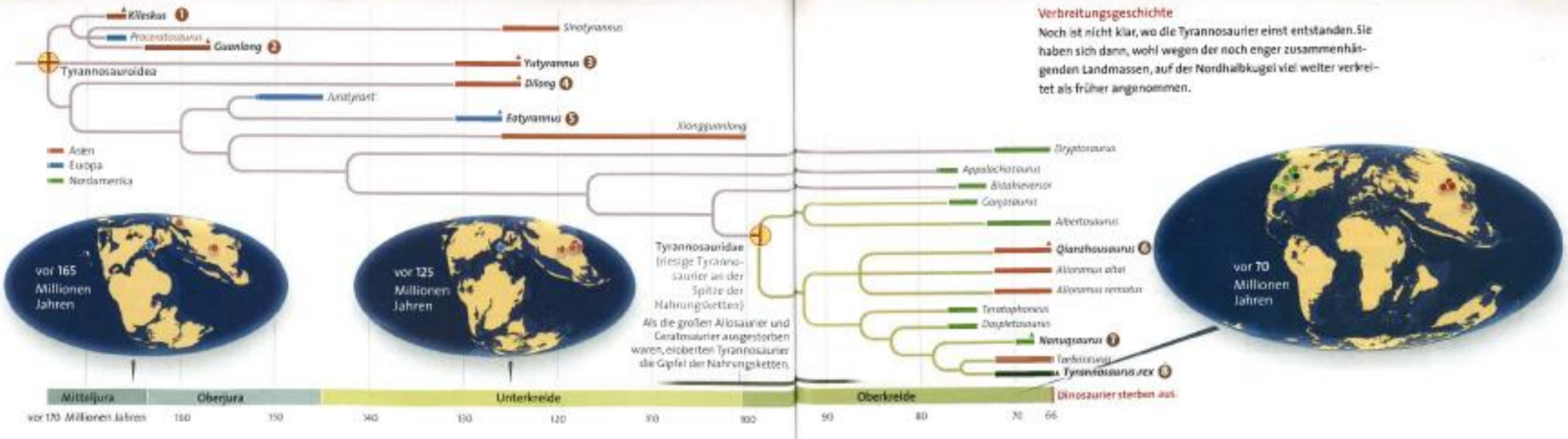
7 *Nanuqsaurus*
Das Tier aus Nordalaska zeigt die bisher nördlichste Verbreitung von Tyrannosauriern. Es wirkt fast wie eine Miniaturausgabe von *T. rex*, was eine Anpassung an das dürftige arktische Nahrungsangebot gewesen sein könnte.

8 *Tyrannosaurus rex*
Er zählt zu den größten Landraubtieren aller Zeiten. Diesen Rang machen ihm höchstens einige entfernt verwandte Raubsaurier aus anderen Gruppen streitig.



Von den bescheidenen Anfängen ...

... bis zu Spitzenräubern



Verbreitungsgeschichte

Noch ist nicht klar, wo die Tyrannosaurier einst entstanden. Sie haben sich dann, wohl wegen der noch enger zusammenhängenden Landmassen, auf der Nordhalbkugel viel weiter verbreitet als früher angenommen.

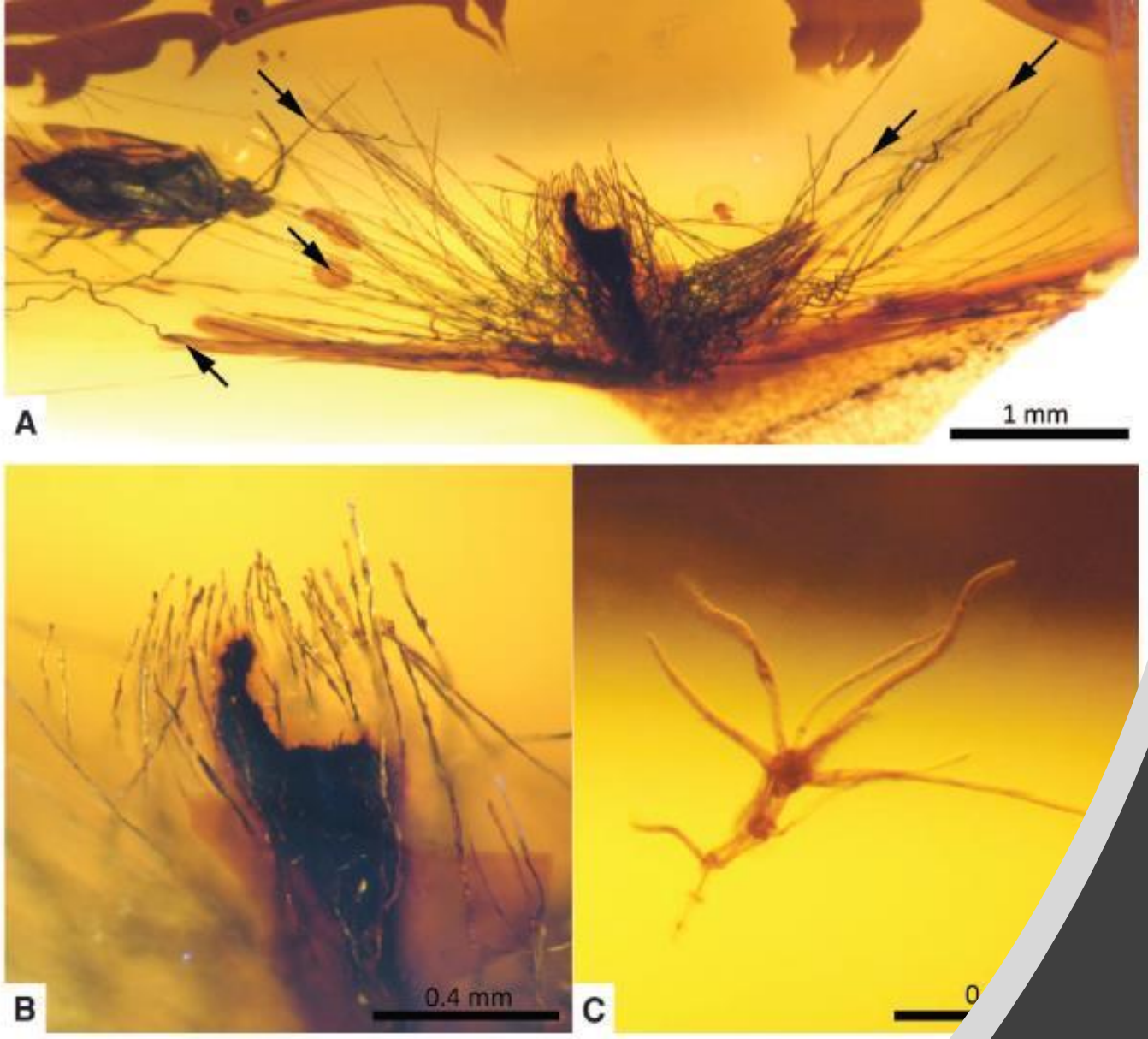


Fig. 1. Photomicrographs of TMP 96.9.334 and comparison image of a tri
Canadian amber. (**A**) Overview of TMP 96.9.334, with dislocated barbules i
barbule bases. (**B**) Cross section of rachis where it is truncated at the sur
with rachis surrounded by truncated barbule apices. (**C**) Stellate trich
specimen).

2011 Dinosaurierfedern in kanadischem Bernstein entdeckt

Gefiederte Dinosaurier

Feathers were widespread even among dinosaurs, such as *Kulindadromeus*, that were not closely related to birds.

24.6.2016 | Medienmitteilung

Haare, Federn und Schuppen haben vieles gemeinsam

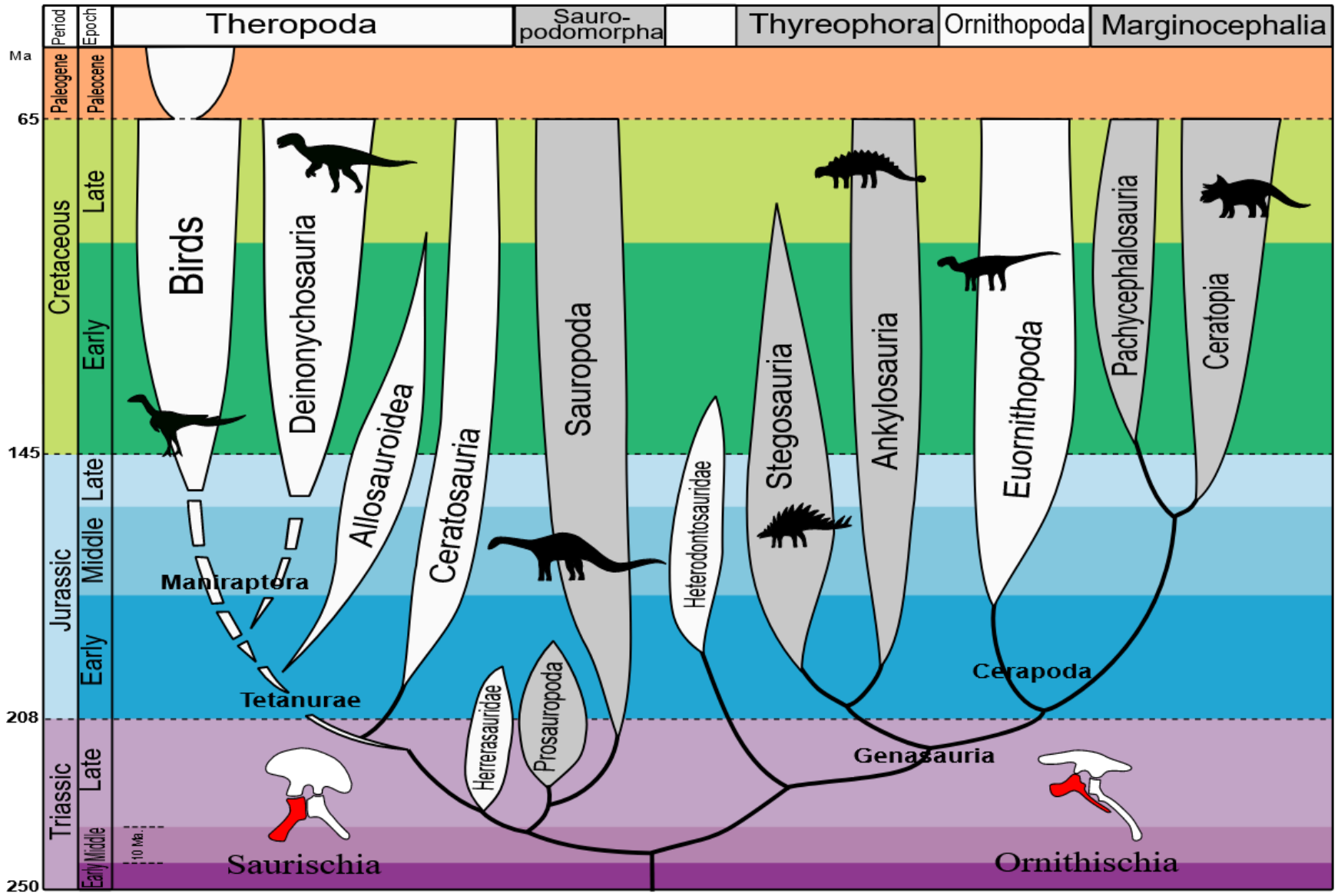
Absender
Universität Genf

UNIVERSITÉ DE GENÈVE

Die mögliche evolutionäre Verwandtschaft zwischen Säugetierhaar, Vogelfedern und Reptilienschuppen wird schon während Jahrzehnten debattiert. Nun konnten Forscher der Universität Genf (UNIGE) und dem SIB Schweizerischen Institut für Bioinformatik zeigen, dass all diese Hautanhangsgebilde einen gemeinsamen Ursprung haben. Mithilfe neuer Analysen in der Embryonalentwicklung gelang es den Schweizer Biologen, in frühen Entwicklungsstadien identische molekulare und mikroanatomische Merkmale im Haar, der Feder, und der Schuppe festzustellen. Diese neuen Beobachtungen, die heute in der Fachzeitschrift Science Advances publiziert werden, deuten auf einen gemeinsamen Reptilienvorfahren dieser drei Strukturen hin.

Bild: Michel C. Milinkovitch, UNIGE

Die mögliche evolutionäre Verwandtschaft zwischen Säugetierhaar, Vogelfedern und Reptilienschuppen wird schon während Jahrzehnten debattiert. Nun konnten Forscher der Universität Genf (UNIGE) und dem SIB Schweizerischen Institut für Bioinformatik zeigen, dass all diese Hautanhangsgebilde einen gemeinsamen Ursprung haben. Mithilfe neuer


Period
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Birds
Deinonychosauria
Allosauroidea
Ceratosauria
Sauropoda
Stegosauria
Ankylosauria
Euornithopoda
Pachycephalosauria
Ceratopia
145
Jurassic
Late
Middle
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Maniraptora
Tetanurae
Heterodontosauridae
Herrerasauridae
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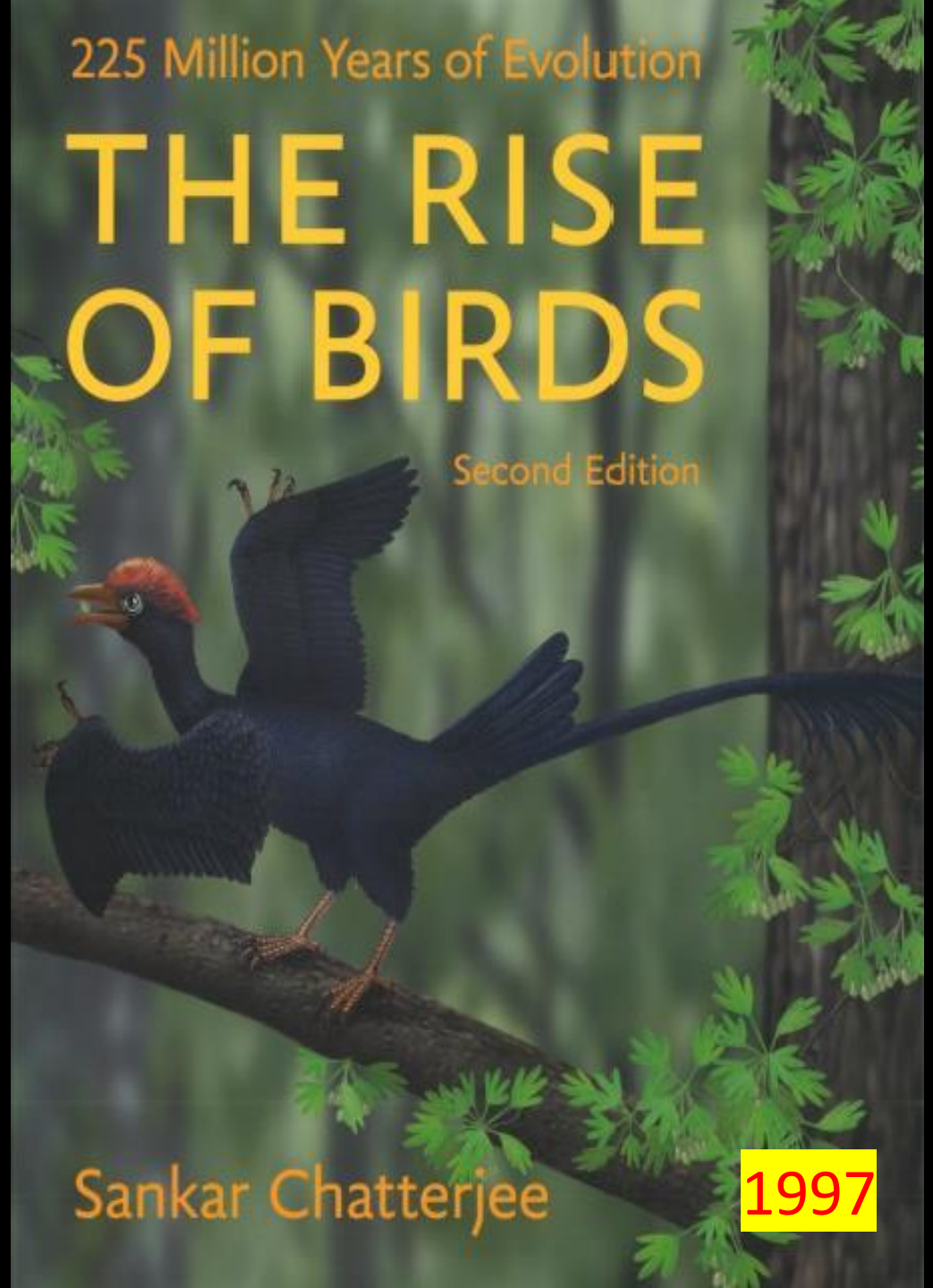
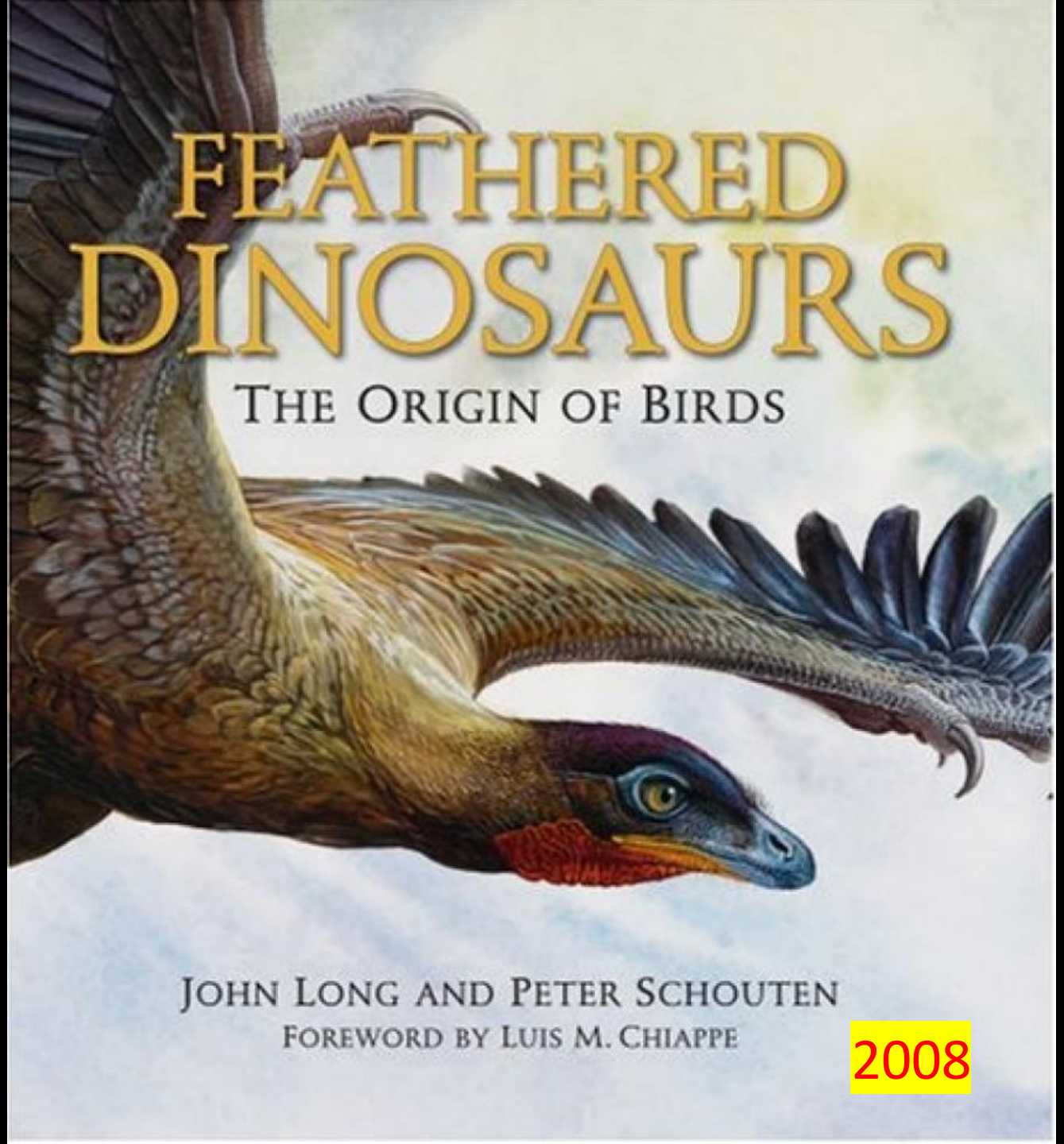
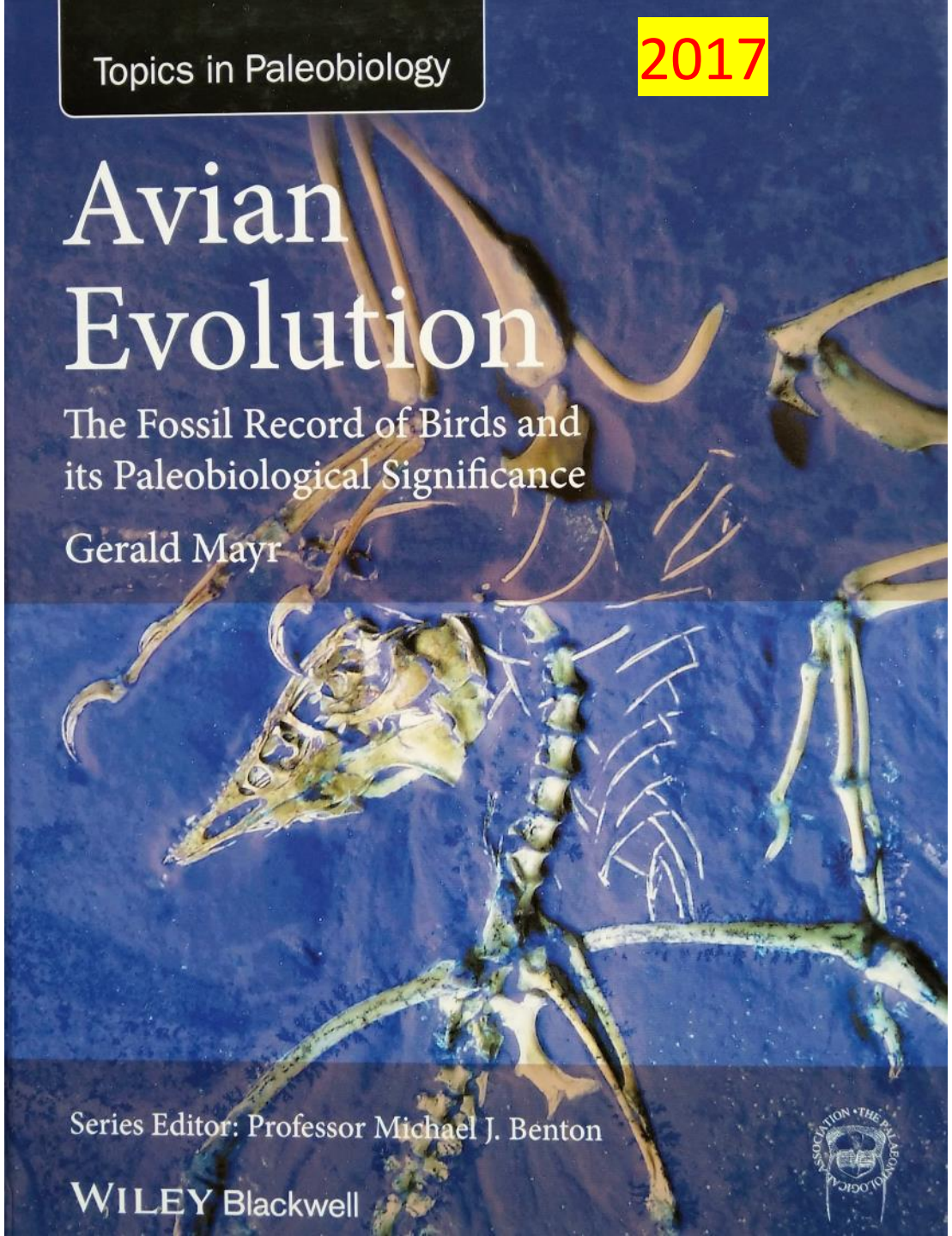
Ornithischia


225 Million Years of Evolution
THE RISE OF BIRDS
Second Edition
Sankar Chatterjee
1997


FEATHERED DINOSAURS
THE ORIGIN OF BIRDS
JOHN LONG AND PETER SCHOUTEN
FOREWORD BY LUIS M. CHIAPPE
2008

- 1861 Archaeopteryx lithographica 150 Mio.
- 1933/2012 Ornithomimus edmontonicus 70 Mio.
- 1981 Avimimus portentosus 80 Mio.
- 1996 Sinosauropteryx prima 125 Mio.
- 1998 Caudipteryx zoui 115 Mio.
- 1998 Rahonavis ostromi 70 Mio.
- 1999 Beipiaosaurus inexpectus 120 Mio.
- 2002 Scansoriopteryx heilmanni 150 Mio.
- 2003 Microraptor gui 115 Mio.
- 2004 Dilong paradoxus 120 Mio.
- 2006 Juravenator starki 150 Mio.
- 2008 Epidexipteryx hui 165 Mio.
- 2008 Similicaudipteryx yixianensis 120 Mio.
- 2009 Anchiornis huxleyi 160 Mio.
- 2011 Xiaotingia zhengi 160 Mio.
- 2012 Sciurumimus albersdoerferi 155 Mio.
- 2012 Yutyrannus huali 115 Mio.
- 2013 Aurornis xui 160 Mio.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The Fossil Record of Birds and its Paleobiological Significance
Gerald Mayr
Series Editor: Professor Michael J. Benton
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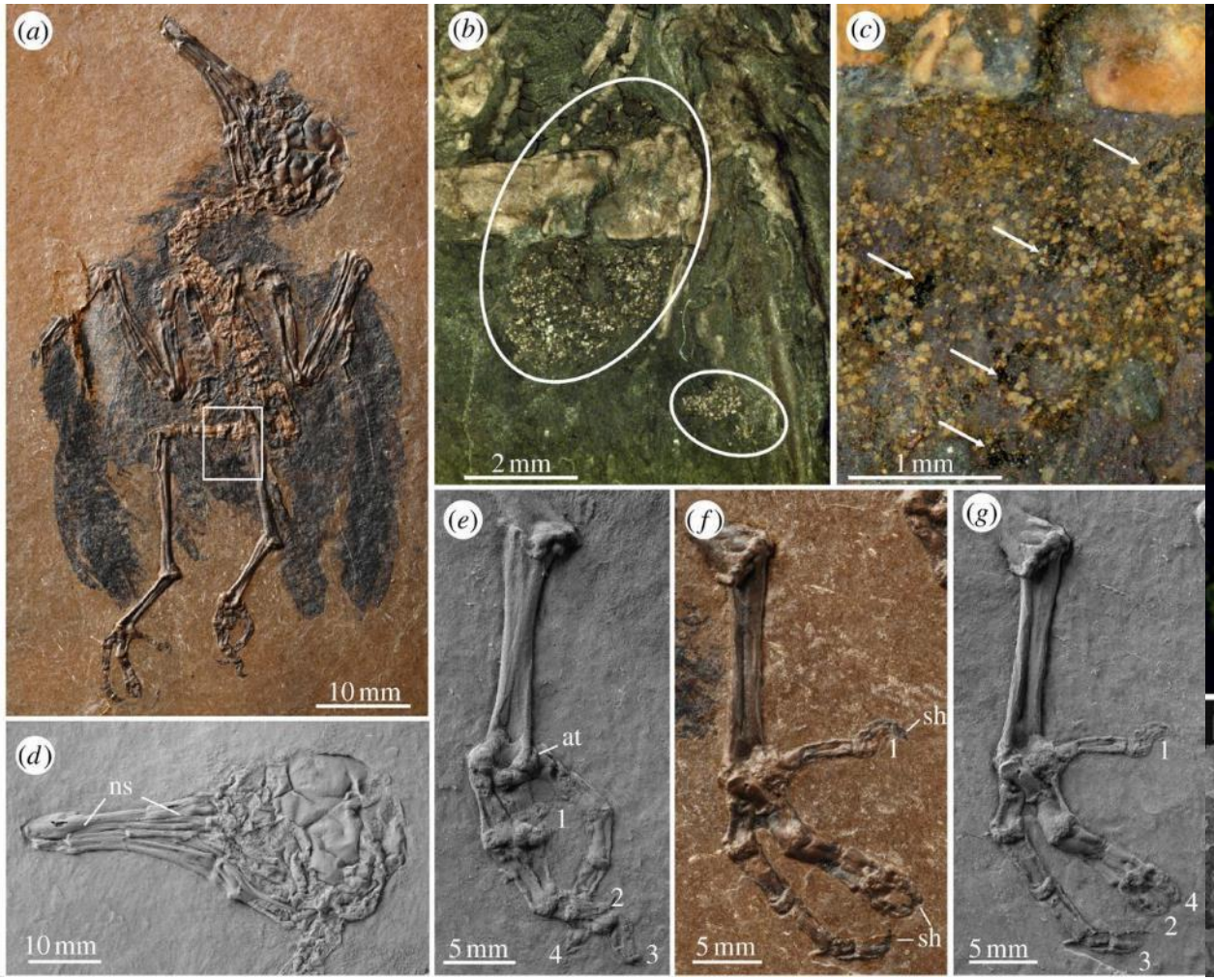
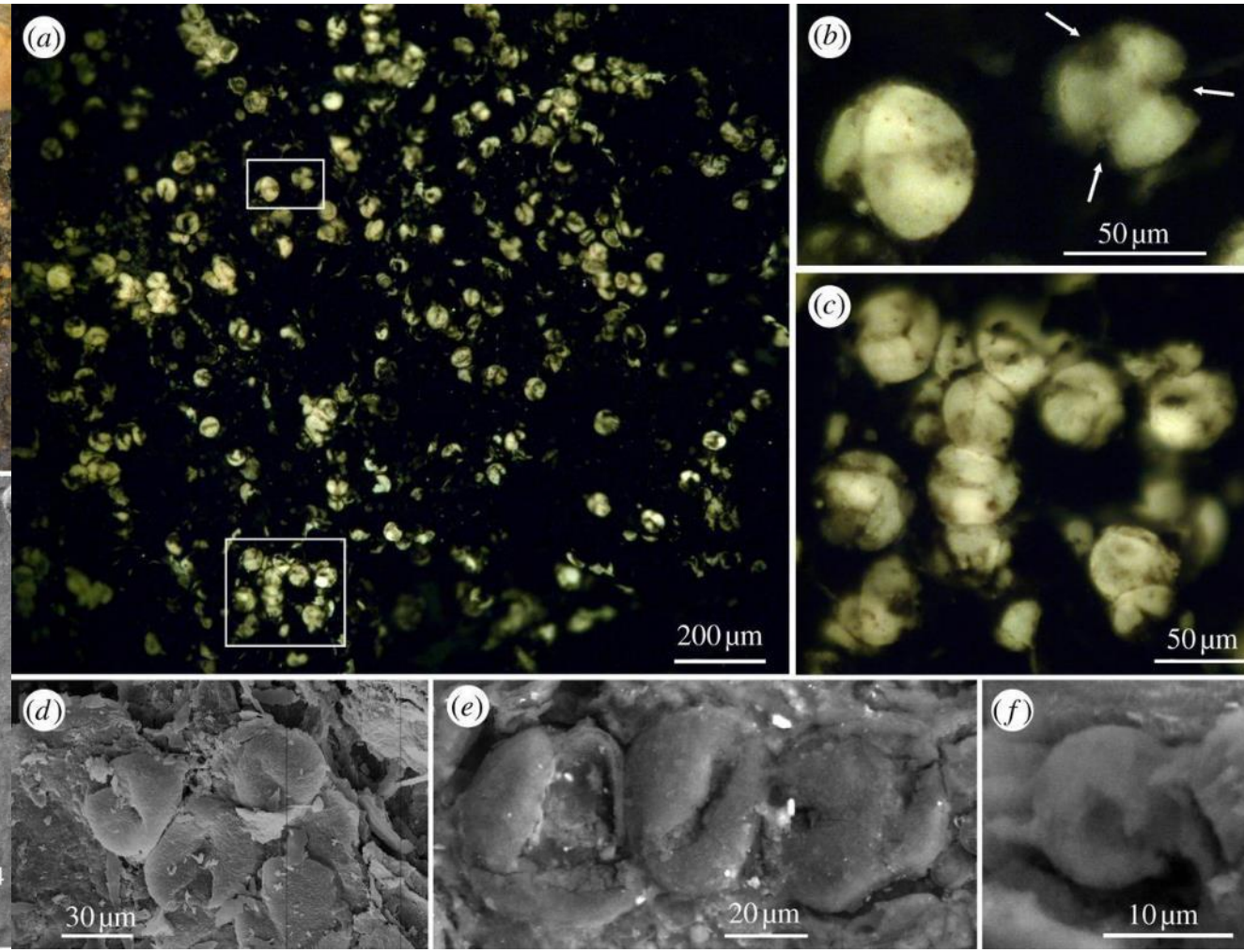


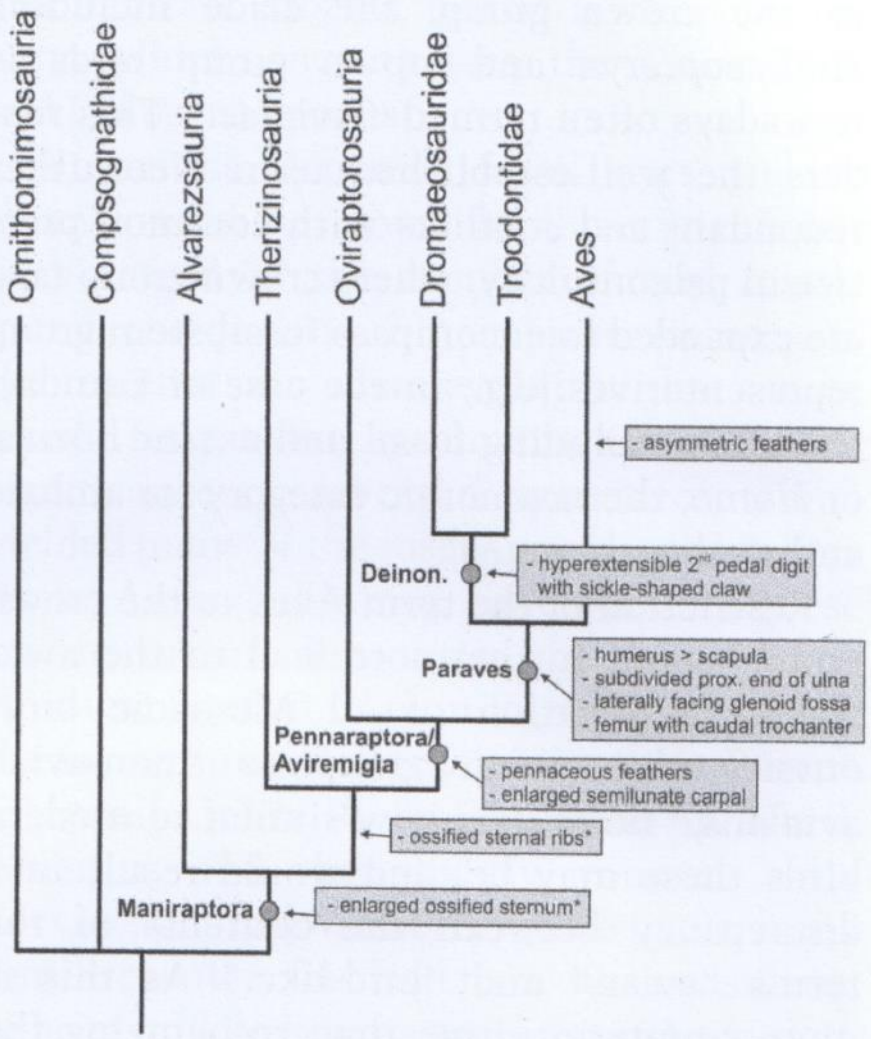
Pumiliornis tesselatus (Mayr 1999)



Mageninhalt Blütenpollen (39 MYA)

Messelirrisor (Mayr 2000)
Ur-Wiedehopf (40 MYA)

Figure 1.2 Phylogenetic interrelationships of birds and their closest theropod relatives, with some key apomorphies characterizing major groups (after Makovicky and Zanno 2011; Turner et al. 2012). The asterisked characters are absent in *Archaeopteryx* and the Troodontidae.



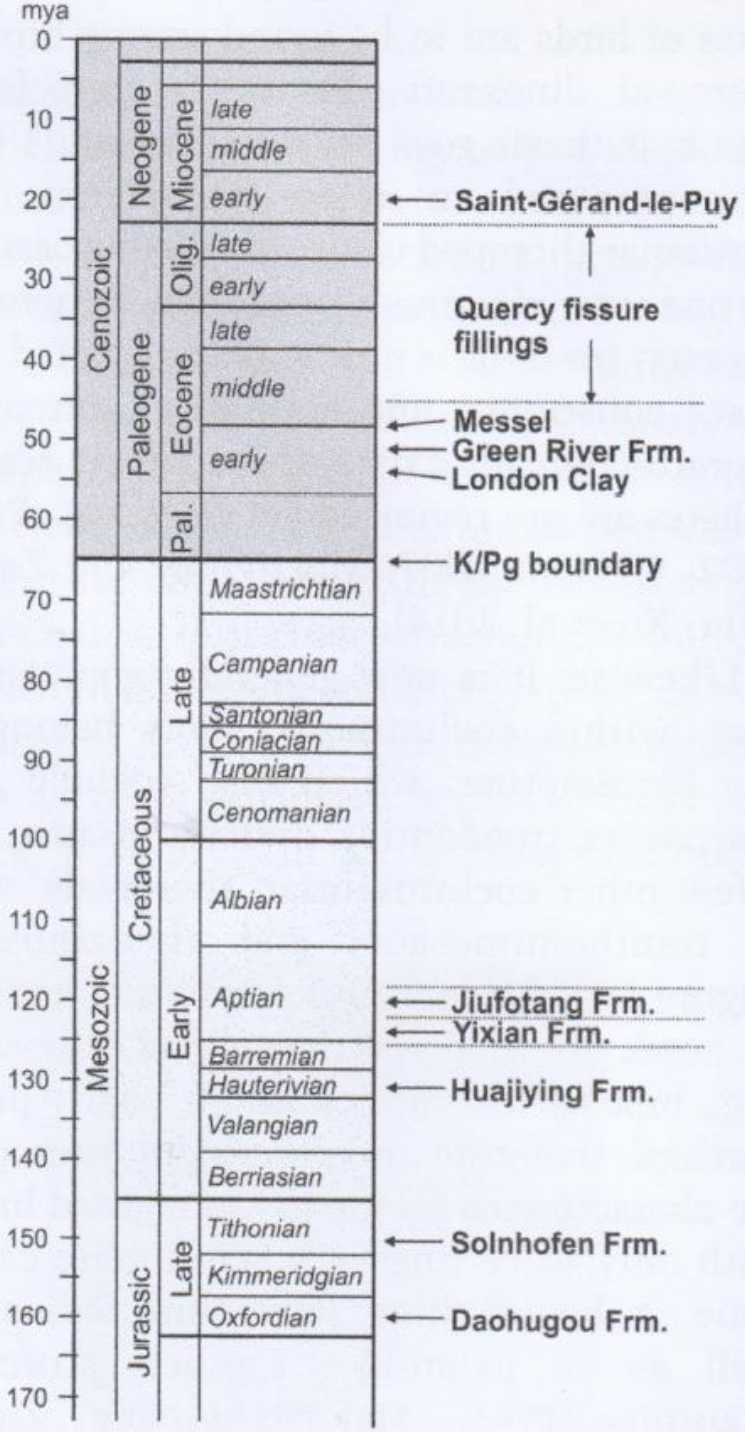
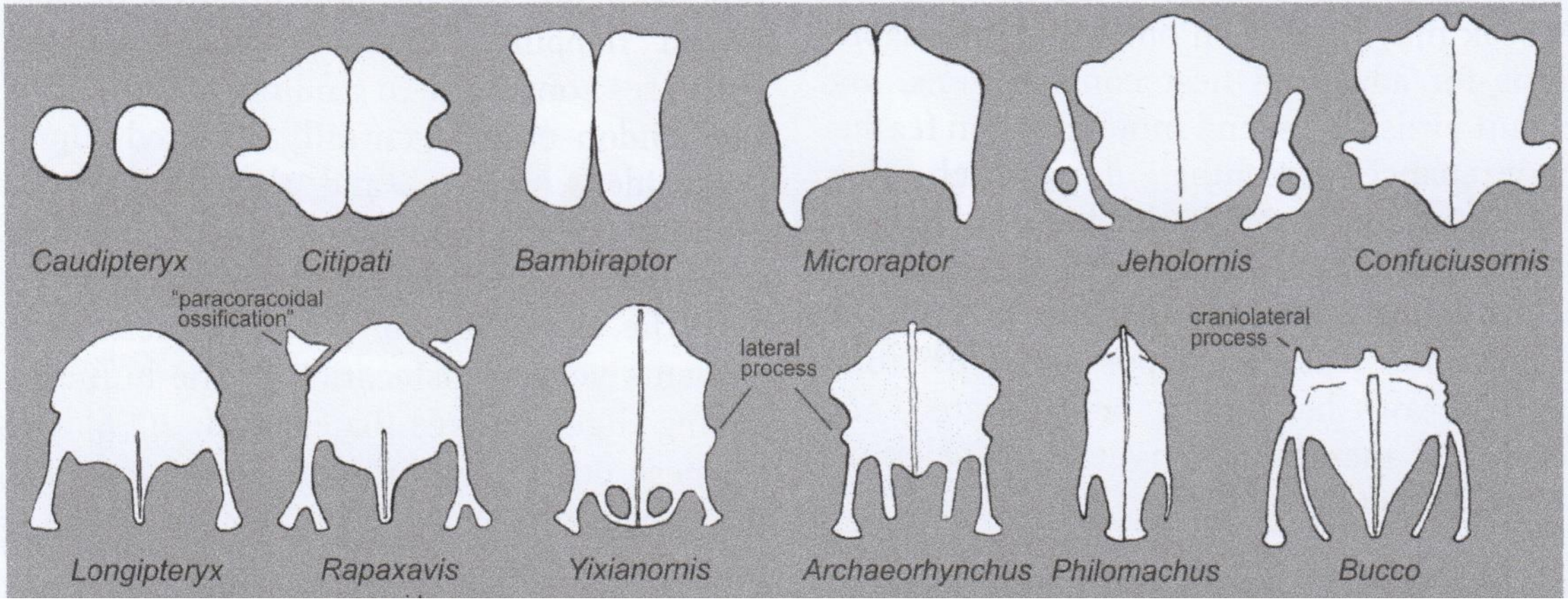


Figure 4.6 Ossified sternal plates and sternum (upper two rows), of oviraptorosaurs (*Caudipteryx, Citipati*), dromaeosaurs (*Bambiraptor, Microraptor*), and various early avians. *Philomachus* (Charadriiformes, Scolopacidae) and *Bucco* (Piciformes, Bucconidae) exemplify two different sternum morphologies of extant birds. Fossil sterna after Zheng et al. (2012), furcula of *Sapeornis* after Gao et al. (2012). Not to scale.



Caudipteryx
Oviraptorosauria
140 MYA

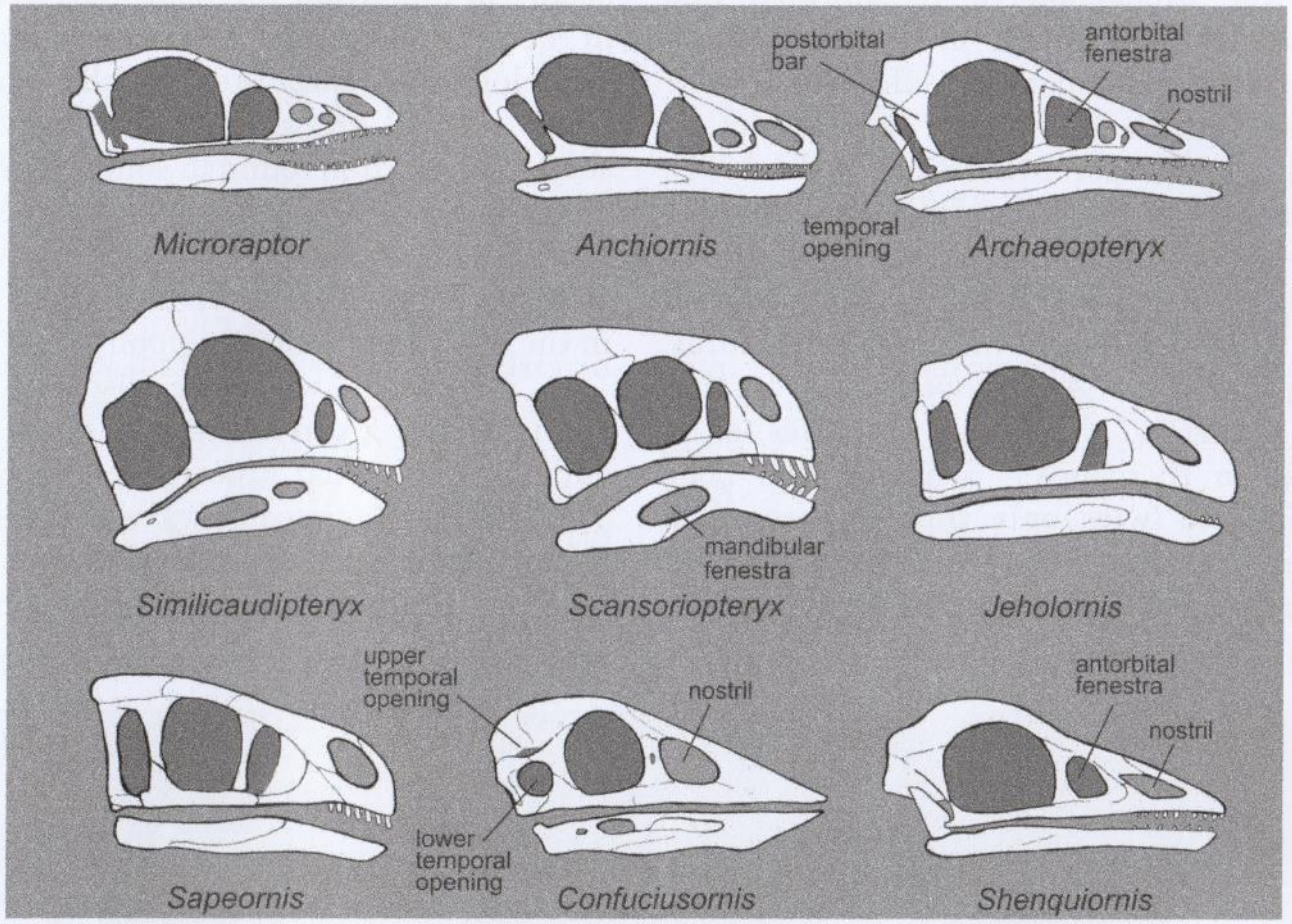
Bambiraptor
Dromaeosauridae
72 MYA

Citipati
Oviraptoridae
68 MYA

Confuciusornis
Avialae
120 MYA

Reduktion der Bezahnung

Figure 4.3 Schematic depiction of the skull of early avians and close avian relatives. Note the similar shapes of the skulls of the oviraptorosaur *Similicaudipteryx*, the scansoriopterygid *Scansoriopteryx*, and the basal avians *Jeholornis* and *Sapeornis* on the one hand, and those of *Archaeopteryx* and the enantiornithine *Shenqiornis* on the other. Adapted from Xu et al. (2011) and O'Connor and Chiappe (2011). Not to scale.



Reduktion des Kleinfingers

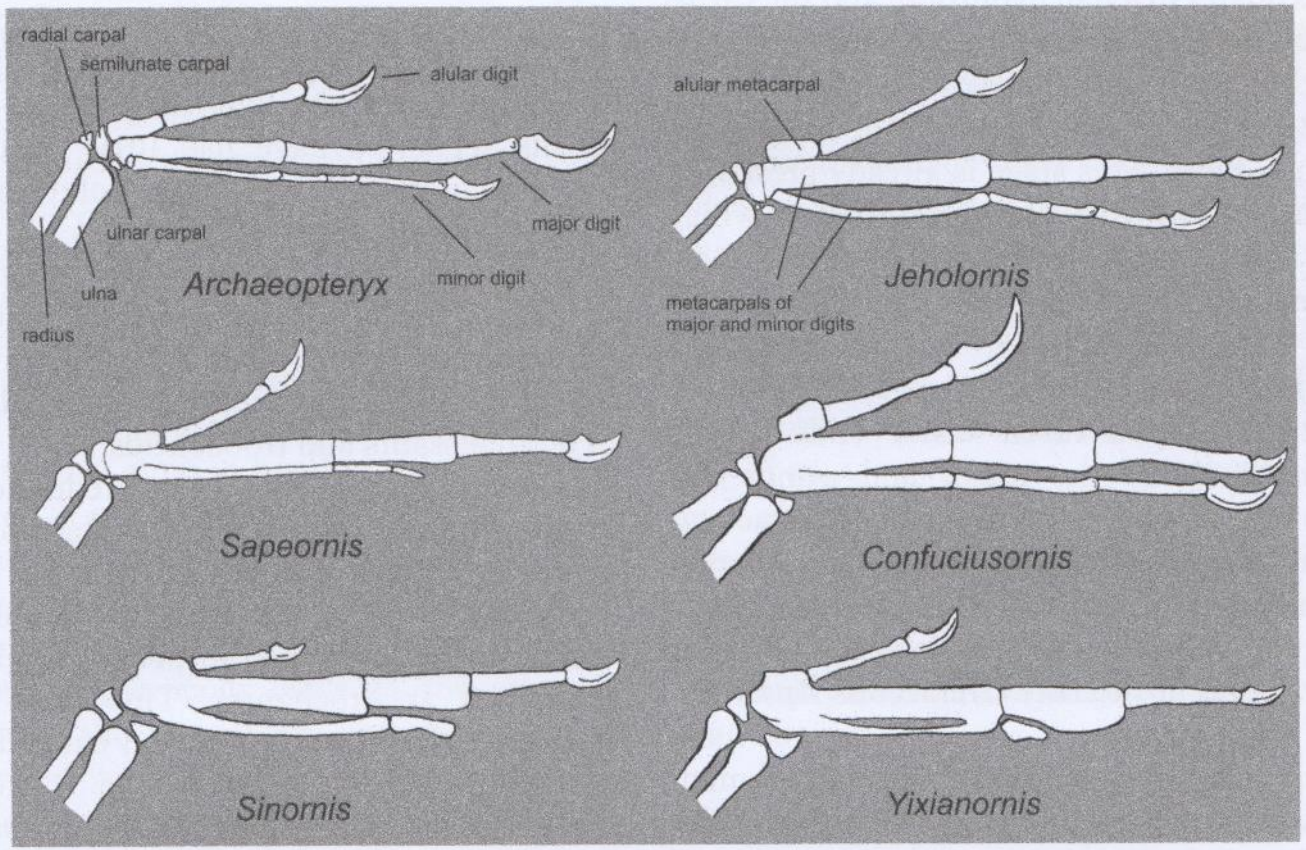


Figure 4.7 Semi-schematic reconstructions of the hand skeleton of early avians. Note the different degree of the reduction of the minor digit. Not to scale.

Yixianornis
Songlingornithidae
120 MYA

Deinonychidae: Utahraptor

Figure 2.6 Skeletons of (a) the dromaeosaur *Deinonychus* and (b) the troodontid *Troodon*. Not to scale. Reconstructions © Scott Hartman.

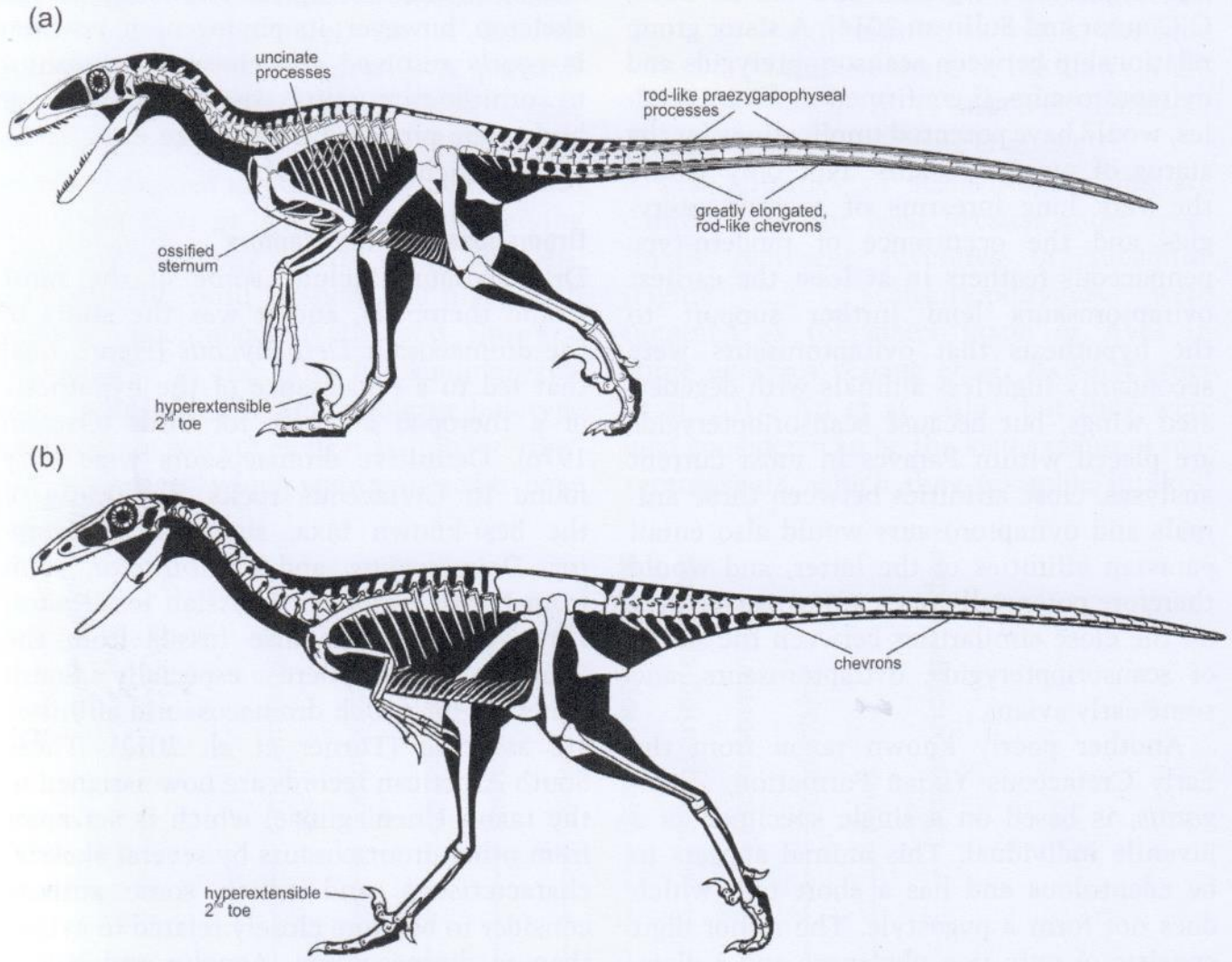


Figure 4.8 Tail morphologies of early avians and close avian relatives. Adapted from O'Connor & Sullivan (2014).

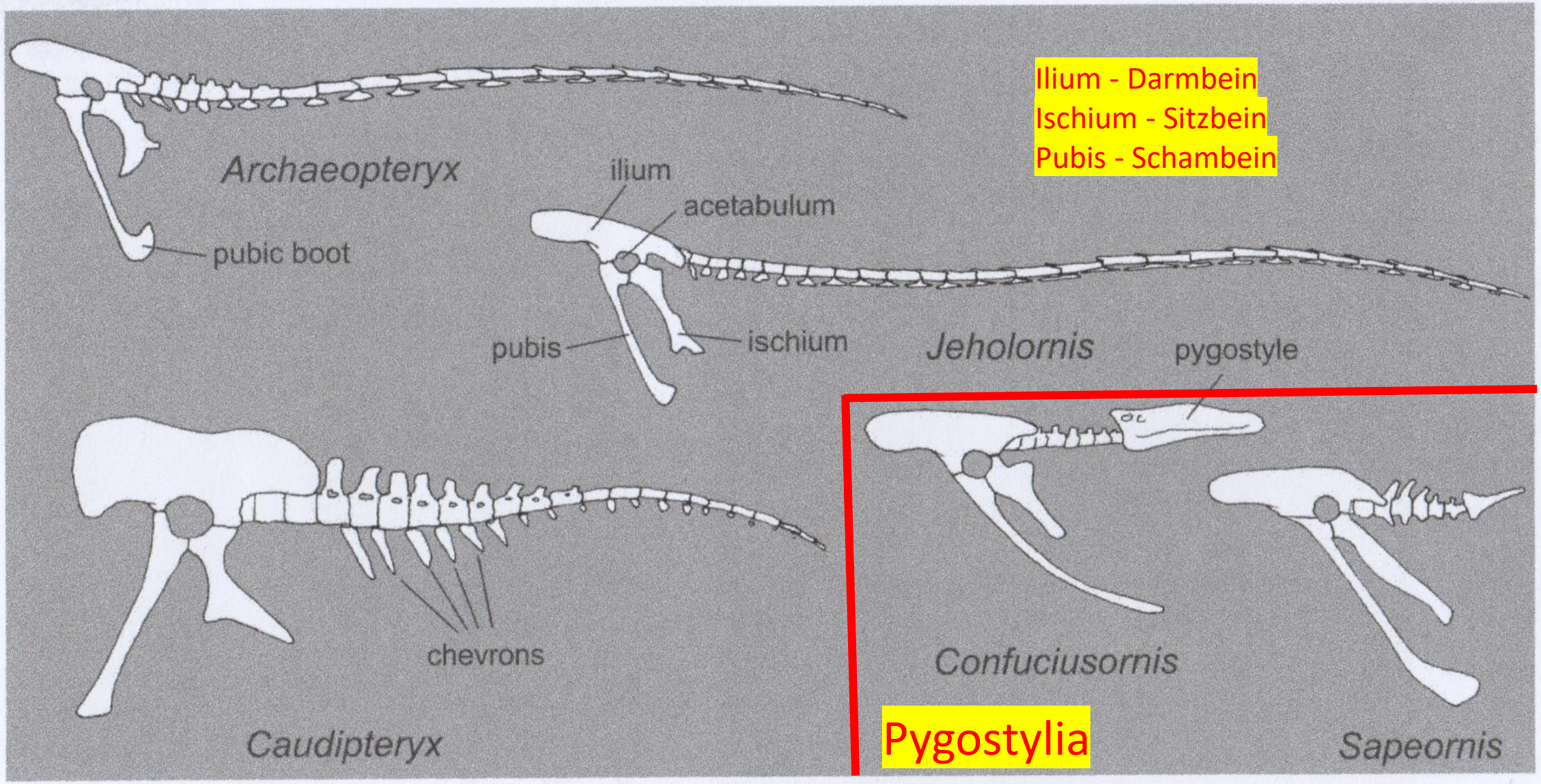


Figure 3.4 Skeleton of the pygostylian *Sapeornis* (Omnivoropterygidae) from the Early Cretaceous Jehol Biota. Reconstruction © Scott Hartman.

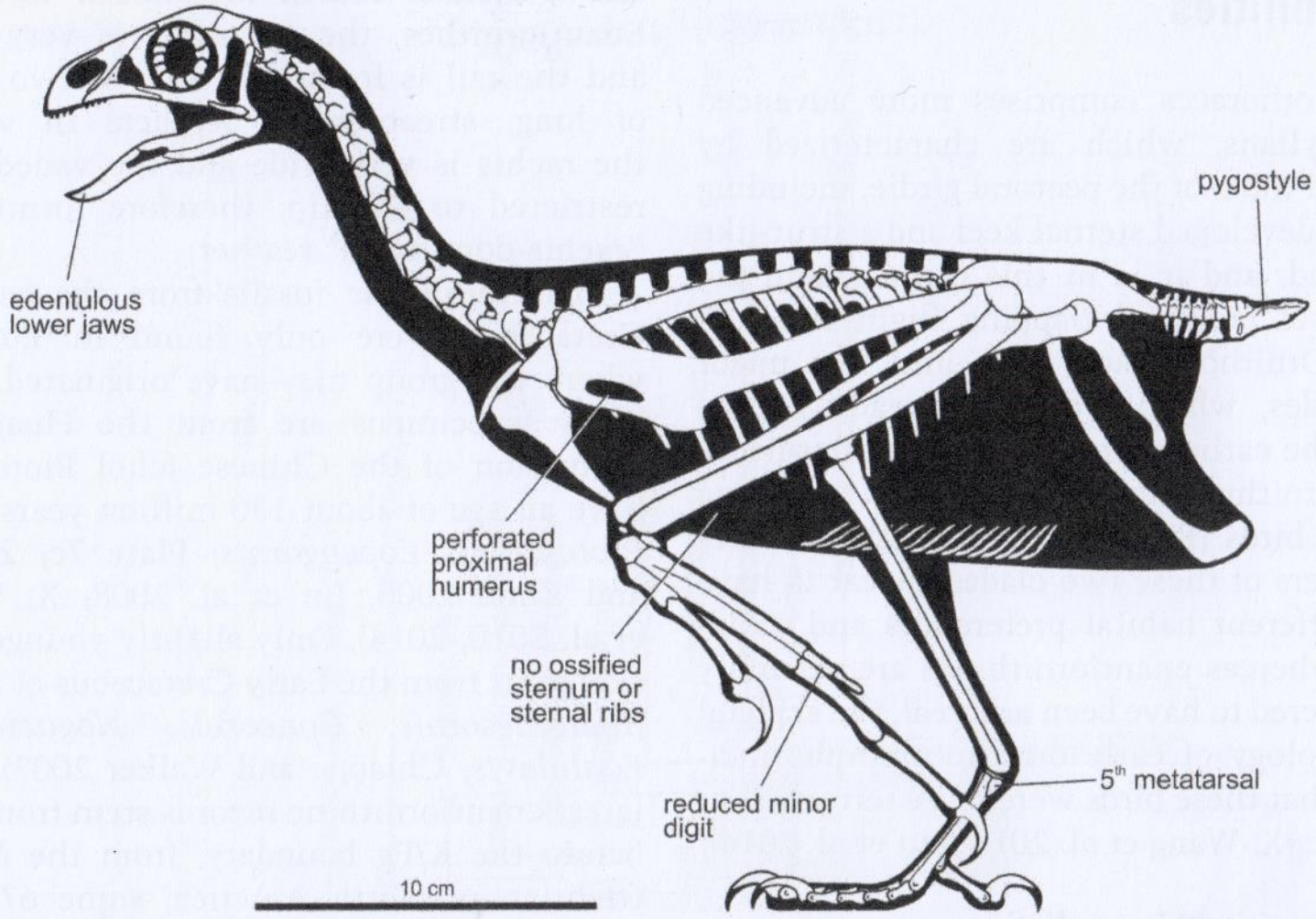
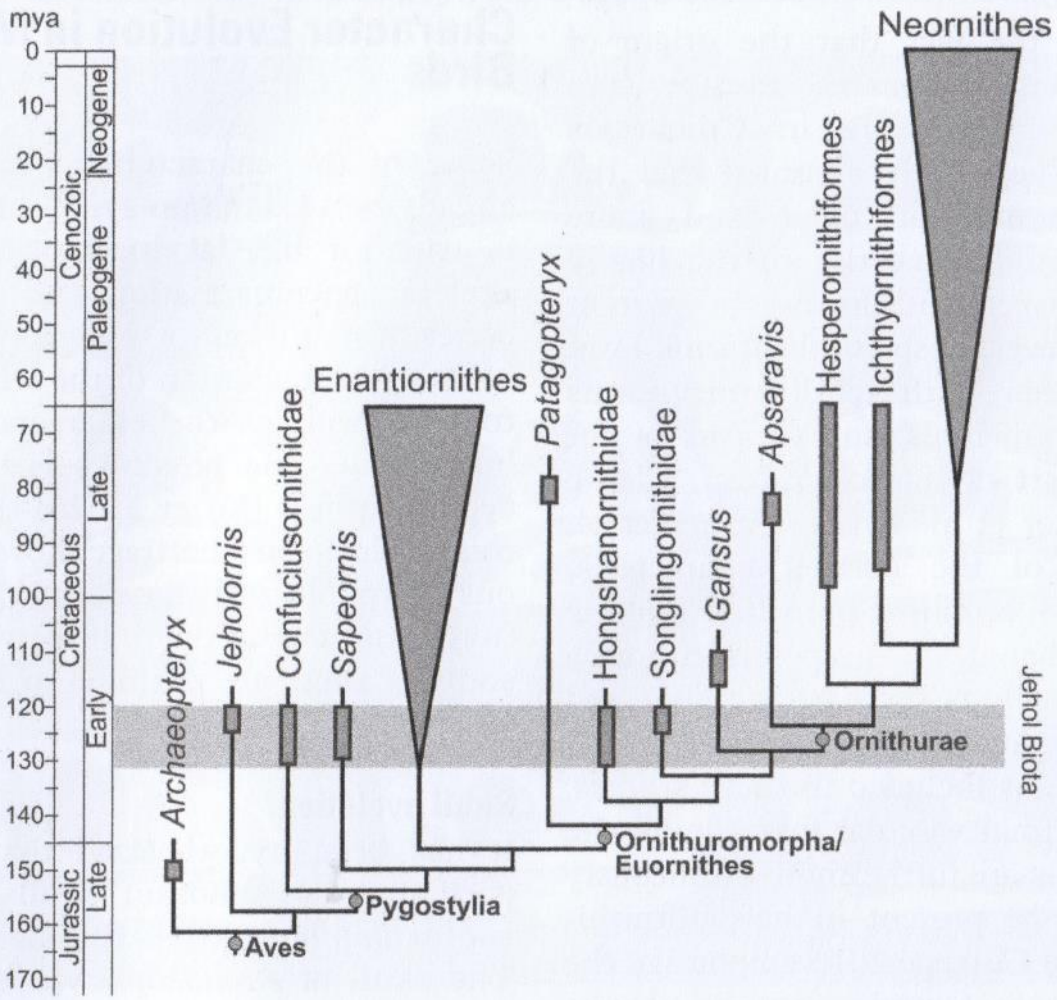
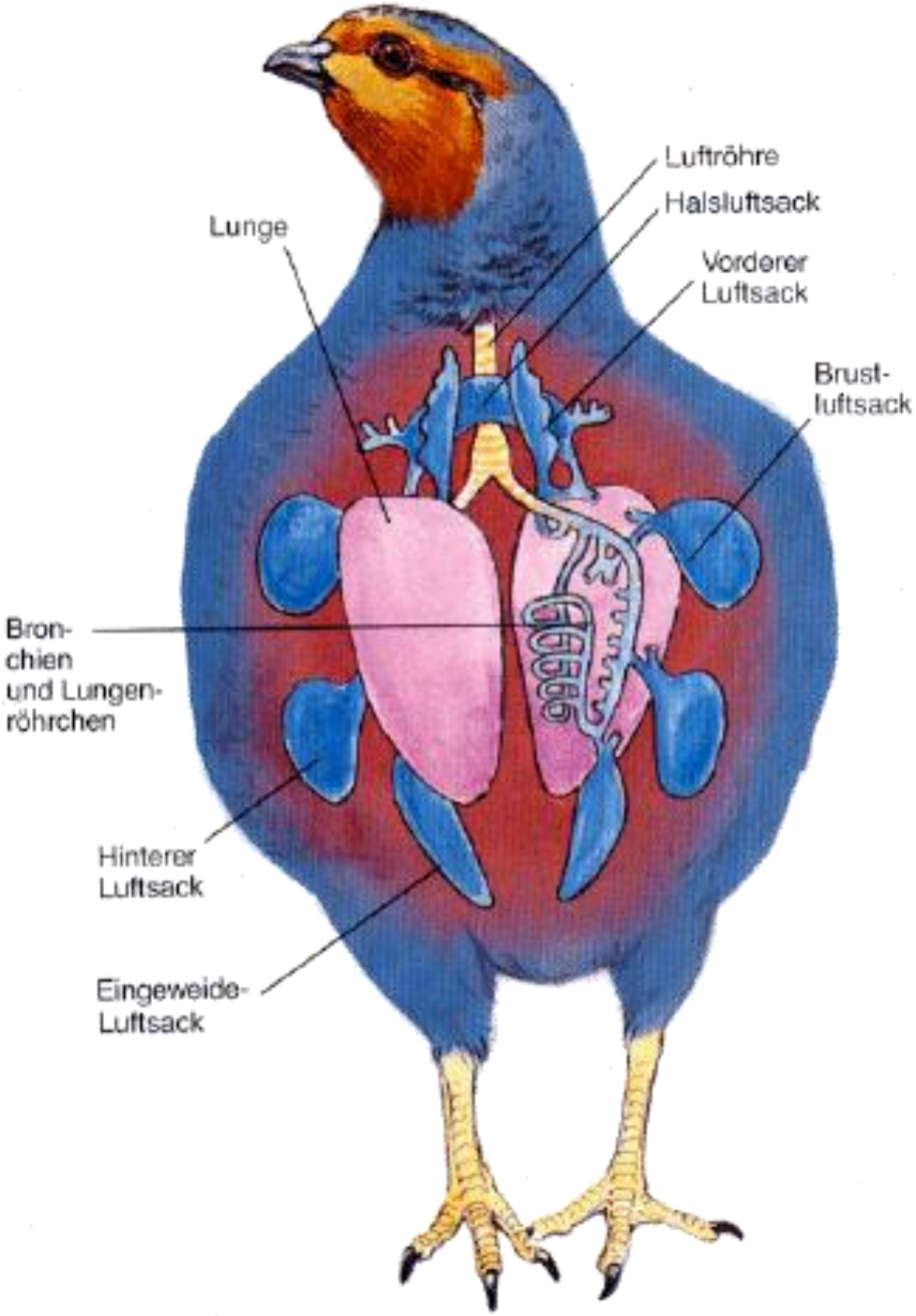
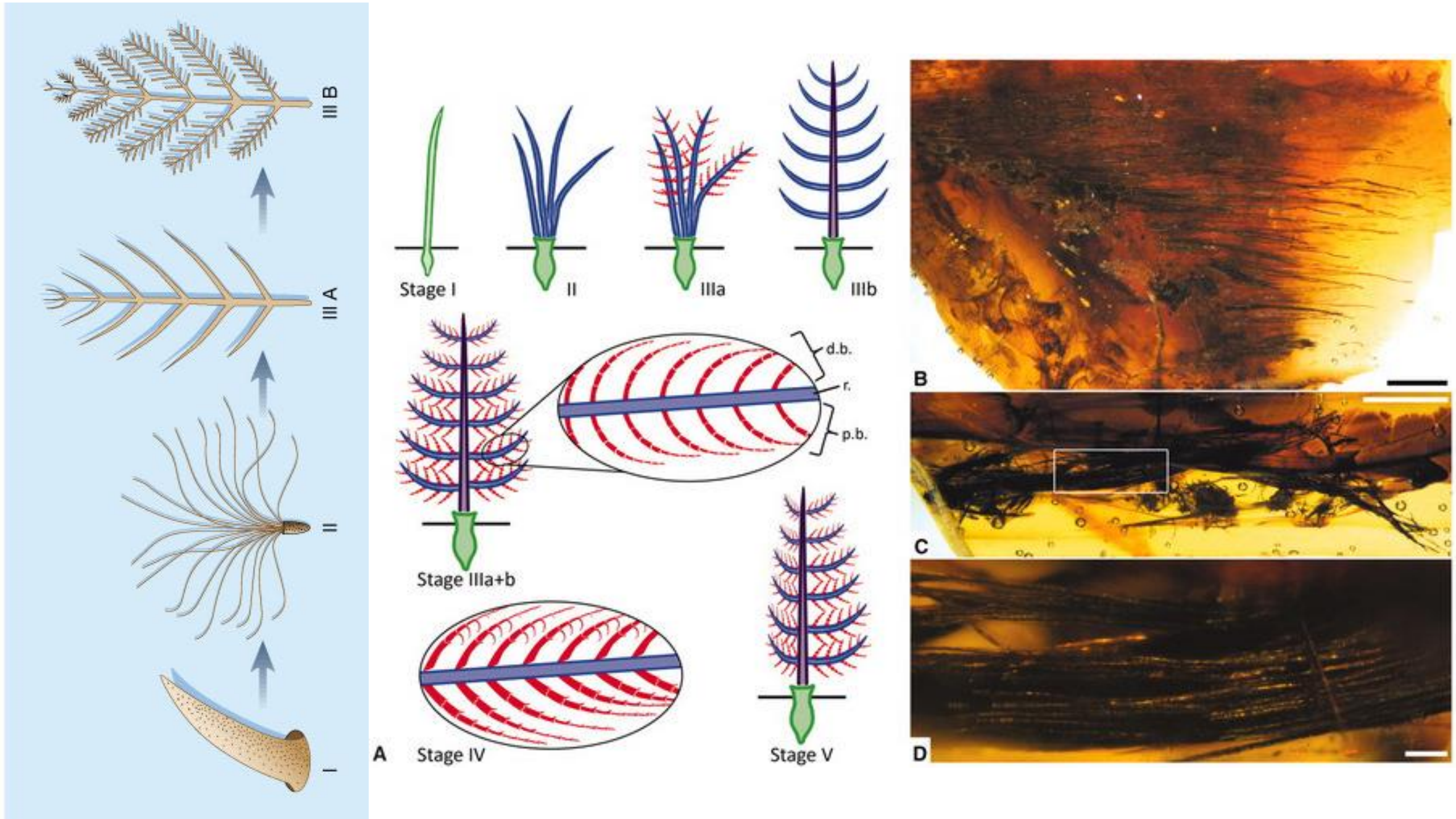


Figure 4.2 Interrelationships of Mesozoic ornithuromorphs as resulting from current analyses of comprehensive data sets (e.g., M. Wang et al. 2015b). Some key apomorphies are indicated; see the text concerning the affinities of *Patagopteryx* and hesperornithiforms.





- Vögel haben im Gegensatz zu Säugetieren eine Durchströmungslunge: Die Bronchien enden nicht stumpf, sondern sind verknüpft. Luftsäcke unterstützen die Luftzirkulation.


III B
III A
II
I
Stage I
II
IIIa
IIIb
d.b.
r.
p.b.
Stage IIIa+b
Stage IV
Stage V
A
B
C
D

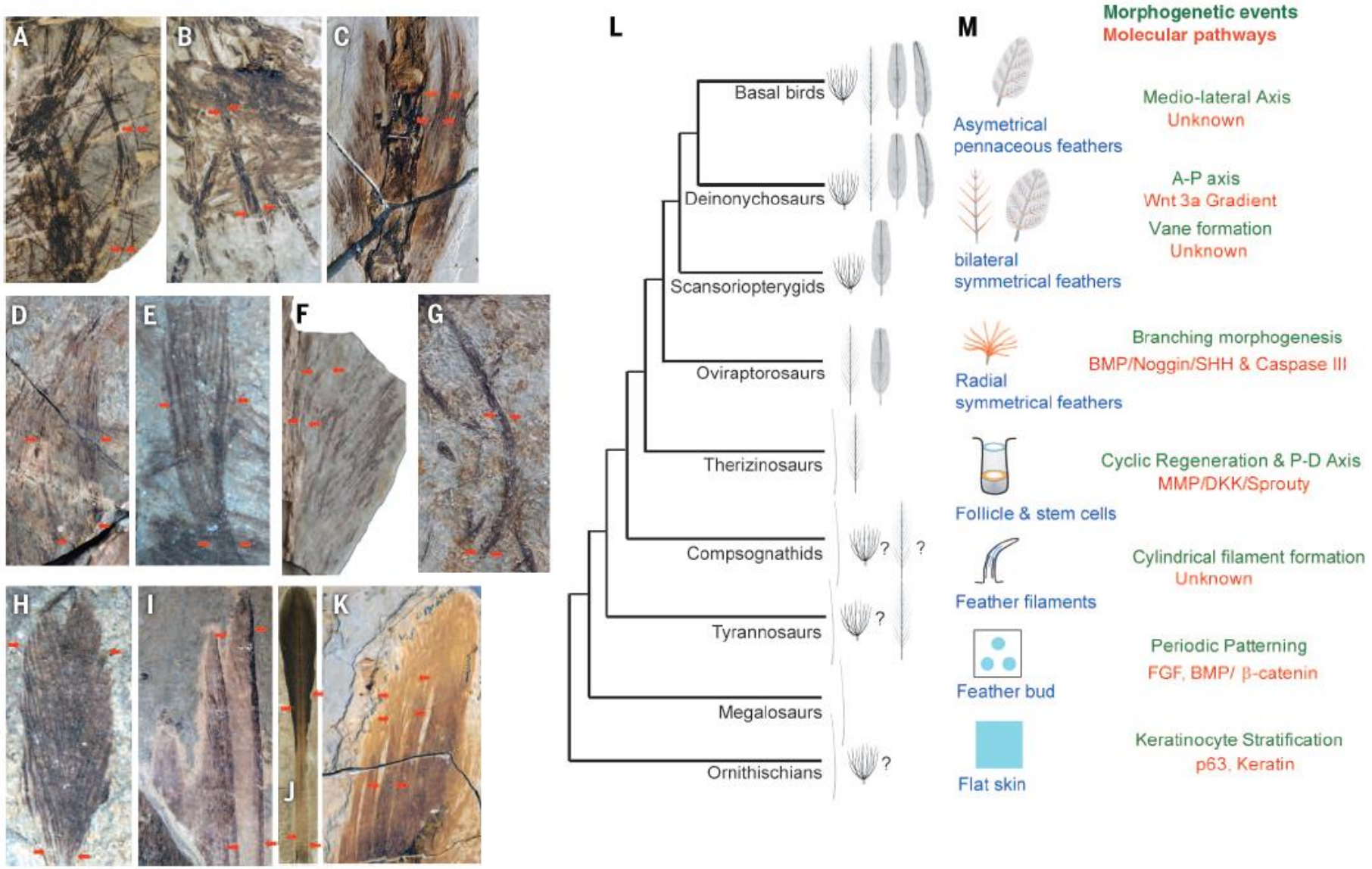


Fig. 5. The morphogenesis and evolution of feathers in dinosaurs. (**A**) Monofilamentous feathers in *Tianyulong*. (**B**) Broad monofilamentous feathers in *Beipiaosaurus*. Radially branched feathers in *Sinosauropteryx* (**C**), *Sinornithosaurus* (**D**), and *Anchiornis* (**E**). Bilaterally branched feathers in *Dilong* (**F**) and *Sinornithosaurus* (**G**). (**H**) Wing flight feathers with symmetrical vanes in *Anchiornis*. (**I**) Pedal flight feathers with asymmetrical vanes in *Microraptor*. (**J**) Rachis-dominant tail feathers in *Confuciusornis*. (**K**) Proximally ribbonlike tail feathers in *Similicaudipteryx*. (**L**) Phylogenetic distribution of major feather morphotypes (monofilamentous, radially branched, bilaterally branched, symmetrical flight, and asymmetrical flight feathers) among dinosaurs. (**M**) Major novel morphogenetic events and molecular pathways during feather evolution. These major feather morphotypes can be explained by selective usage of the five novel "molecular circuits" discussed in the text. Red arrows flank a feather.

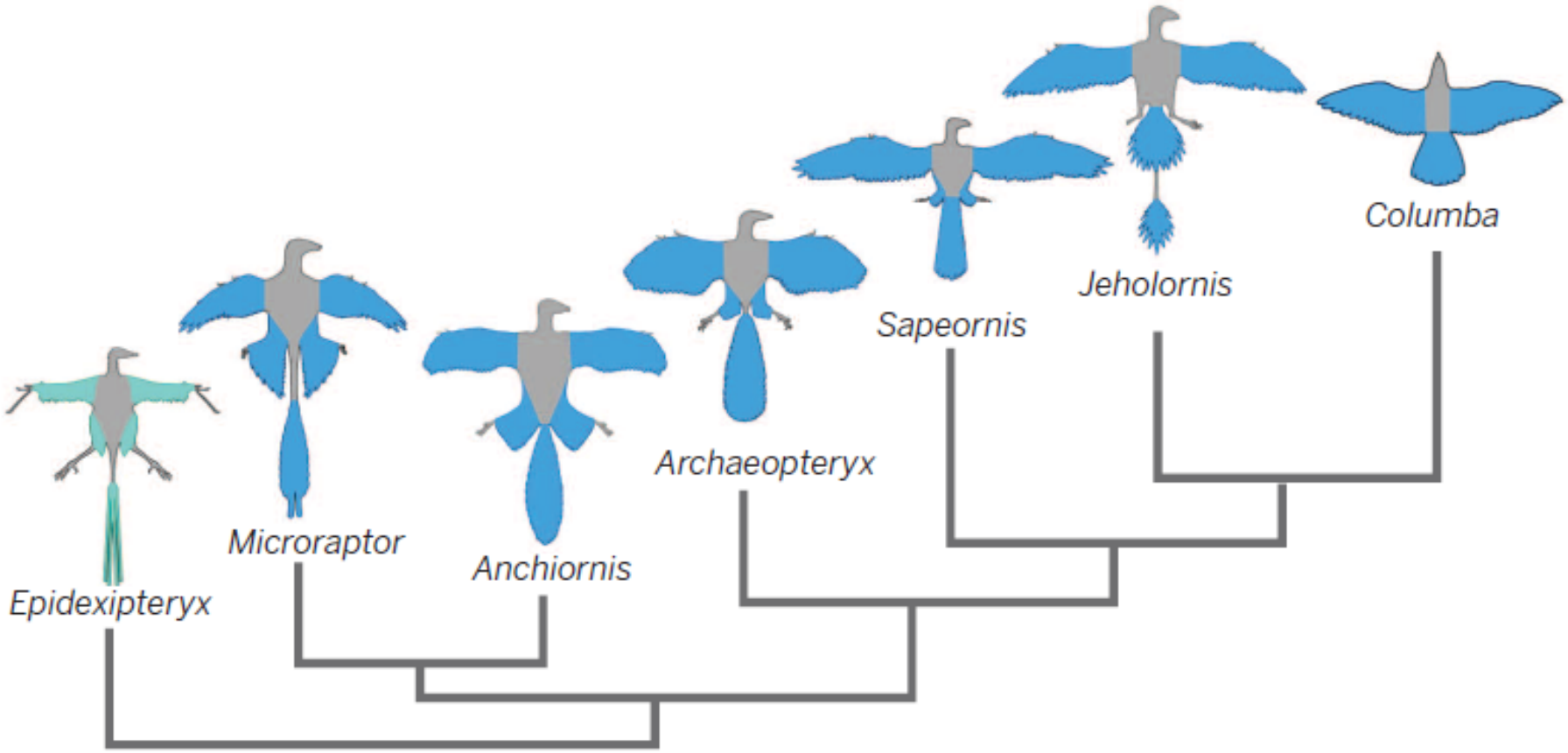


Fig. 6. Airfoils of selected maniraptorans. Airfoils (in blue) of the basal dromaeosaur *Microraptor*, the basal troodontid *Anchiornis*, the basal birds *Archaeopteryx*, *Sapeornis*, and *Jeholornis*, and a modern pigeon. Feathered airfoils are greater in number and are more distally positioned in early birds and their closest theropod relatives than in modern birds. The scansoriopterygid *Epidexipteryx* has stiff downlike feathers (in green) on both the forelimb and hindlimb and long ribbonlike feathers on the tail, the aerodynamic functions of which remain poorly known.

Epidexipteryx

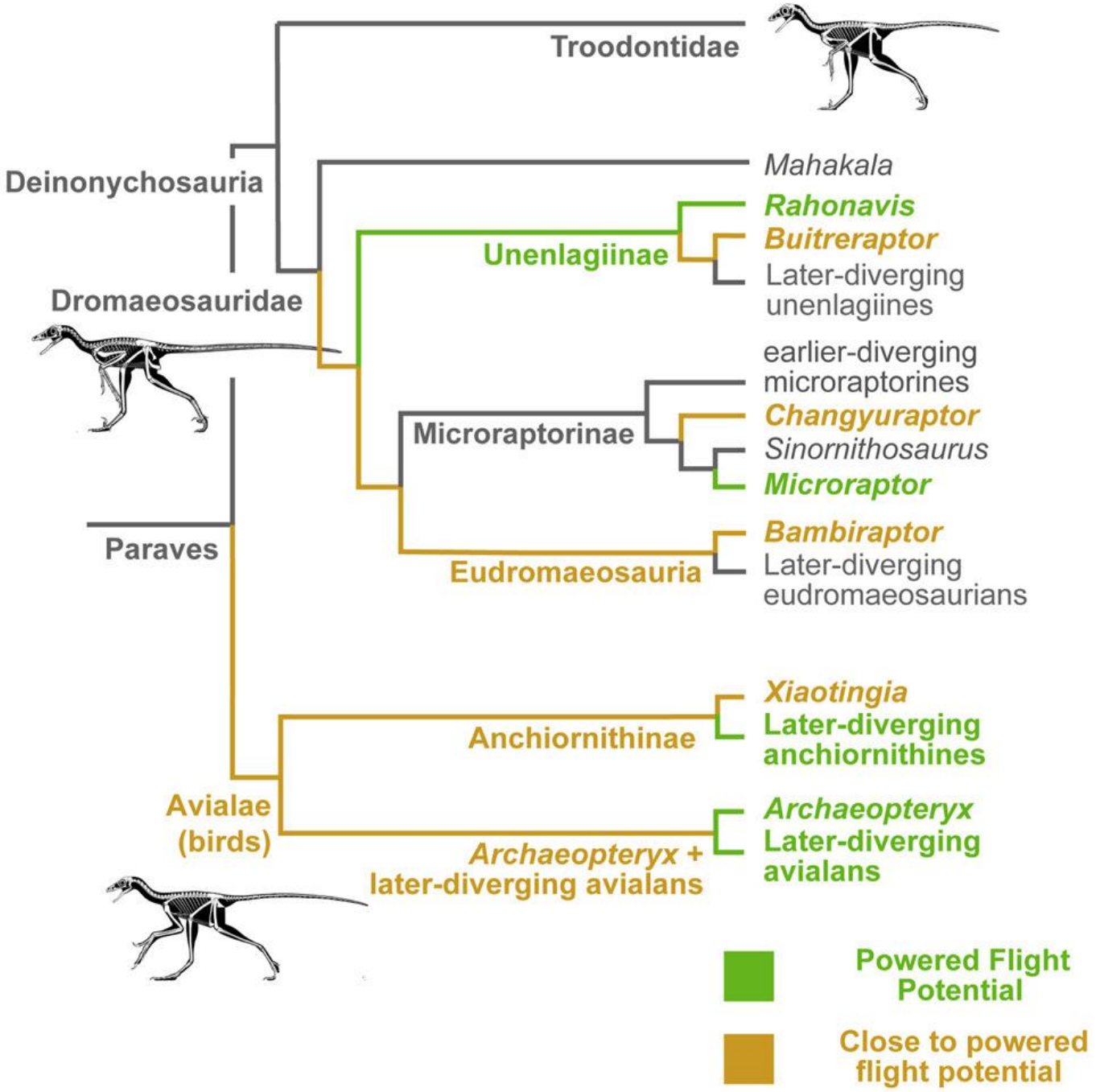
Microraptor

Anchiornis

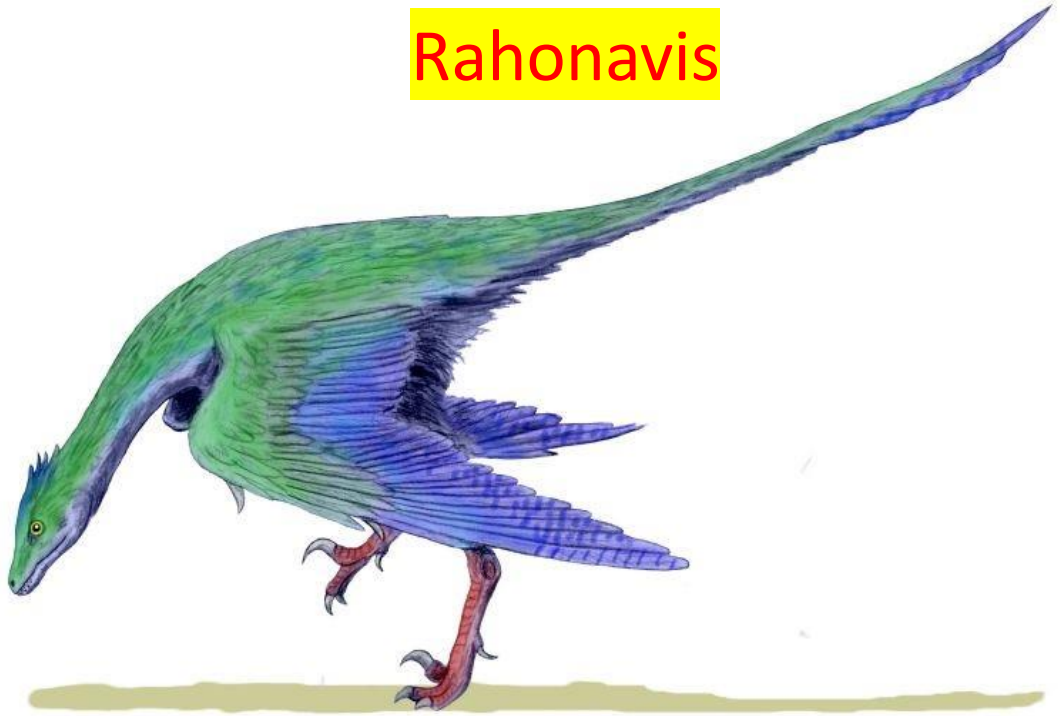
Archaeopteryx

Sapeornis
© 2010

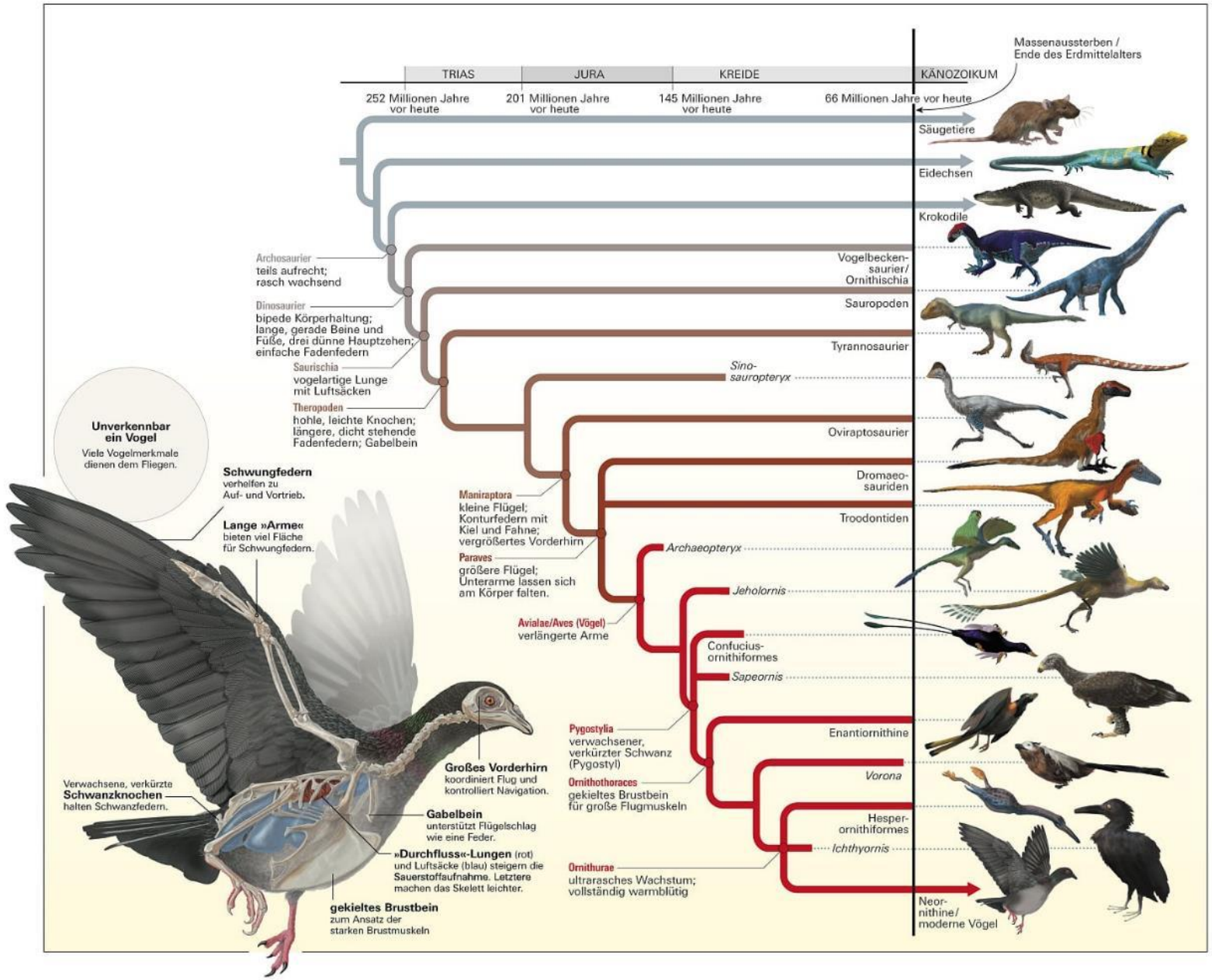
Jeholornis

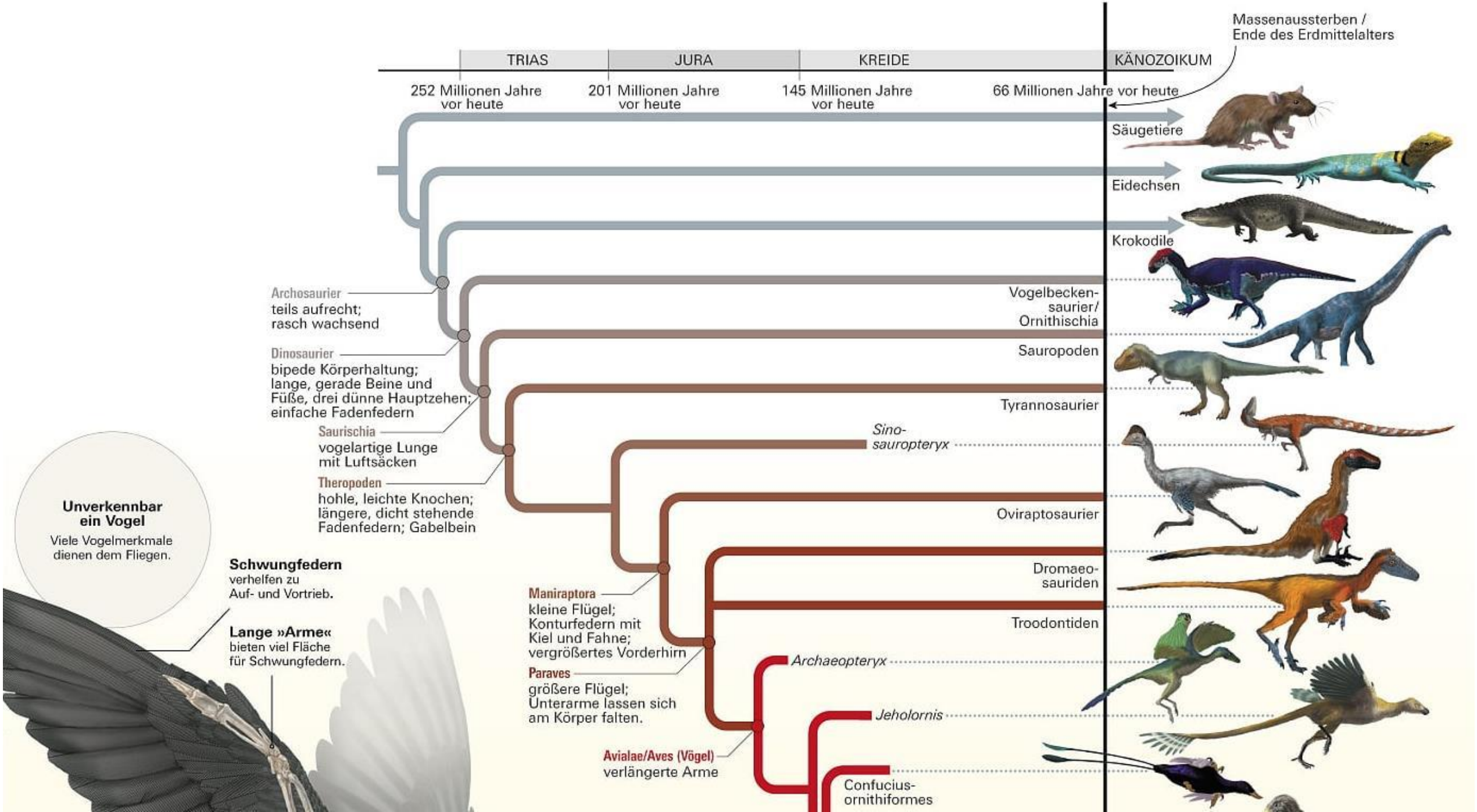


Rahonavis



Changyuraptor


TRIAS
JURA
KREIDE
KÄNOZOIKUM
252 Millionen Jahre vor heute
201 Millionen Jahre vor heute
145 Millionen Jahre vor heute
66 Millionen Jahre vor heute
Massenaussterben / Ende des Erdmittelalters
Säugetiere
Eidechsen
Krokodile
Vogelbecken-saurier/ Ornithischia
Sauropoden
Tyrannosaurier
Sino-sauropteryx
Oviraptosaurier
Dromaeo-sauriden
Troodontiden
Archaeopteryx
Jeholornis
Confucius-ornithiformes
Sapeornis
Enantiornithine
Vorona
Hesper-ornithiformes
Ichthyornis
Neor-nithine/ moderne Vögel
Archosaurier
teils aufrecht; rasch wachsend
Dinosaurier
bipede Körperhaltung; lange, gerade Beine und Füße, drei dünne Hauptzehen; einfache Fadenfedern
Saurischia
vogelartige Lunge mit Luftsäcken
Theropoden
hohle, leichte Knochen; längere, dicht stehende Fadenfedern; Gabelbein
Maniraptora
kleine Flügel; Konturfedern mit Kiel und Fahne; vergrößertes Vorderhirn
Paraves
größere Flügel; Unterarme lassen sich am Körper falten.
Avialae/Aves (Vögel)
verlängerte Arme
Pygostylia
verwachsener, verkürzter Schwanz (Pygostyl)
Ornithothoraces
gekieltes Brustbein für große Flugmuskeln
Ornithurae
ultrarasches Wachstum; vollständig warmblütig
Unverkennbar ein Vogel
Viele Vogelmerkmale dienen dem Fliegen.
Schwungfedern
verhelfen zu Auf- und Vortrieb.
Lange »Arme«
bieten viel Fläche für Schwungfedern.
Großes Vorderhirn
koordiniert Flug und kontrolliert Navigation.
Verwachsene, verkürzte Schwanzknochen
halten Schwanzfedern.
Gabelbein
unterstützt Flügelschlag wie eine Feder.
»Durchfluss«-Lungen (rot) und Luftsäcke (blau) steigern die Sauerstoffaufnahme. Letztere machen das Skelett leichter.
gekieltes Brustbein
zum Ansatz der starken Brustmuskeln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teils aufrecht; rasch wachsend
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bipede Körperhaltung; lange, gerade Beine und Füße, drei dünne Hauptzehen; einfache Fadenfedern
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vogelartige Lunge mit Luftsäcken
Theropoden
hohle, leichte Knochen; längere, dicht stehende Fadenfedern; Gabelbein
Vogelbecken-saurier/ Ornithischia
Sauropoden
Tyrannosaurier
Sino-sauropteryx
Oviraptosaurier
Dromaeo-sauriden
Troodontiden
Maniraptora
kleine Flügel; Konturfedern mit Kiel und Fahne; vergrößertes Vorderhirn
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Archaeopteryx
Jeholornis
Avialae/Aves (Vögel)
verlängerte Arme
Confucius-ornithiformes
Unverkennbar ein Vogel
Viele Vogelmerkmale dienen dem Fliegen.
Schwungfedern
verhelfen zu Auf- und Vortrieb.
Lange »Arme«
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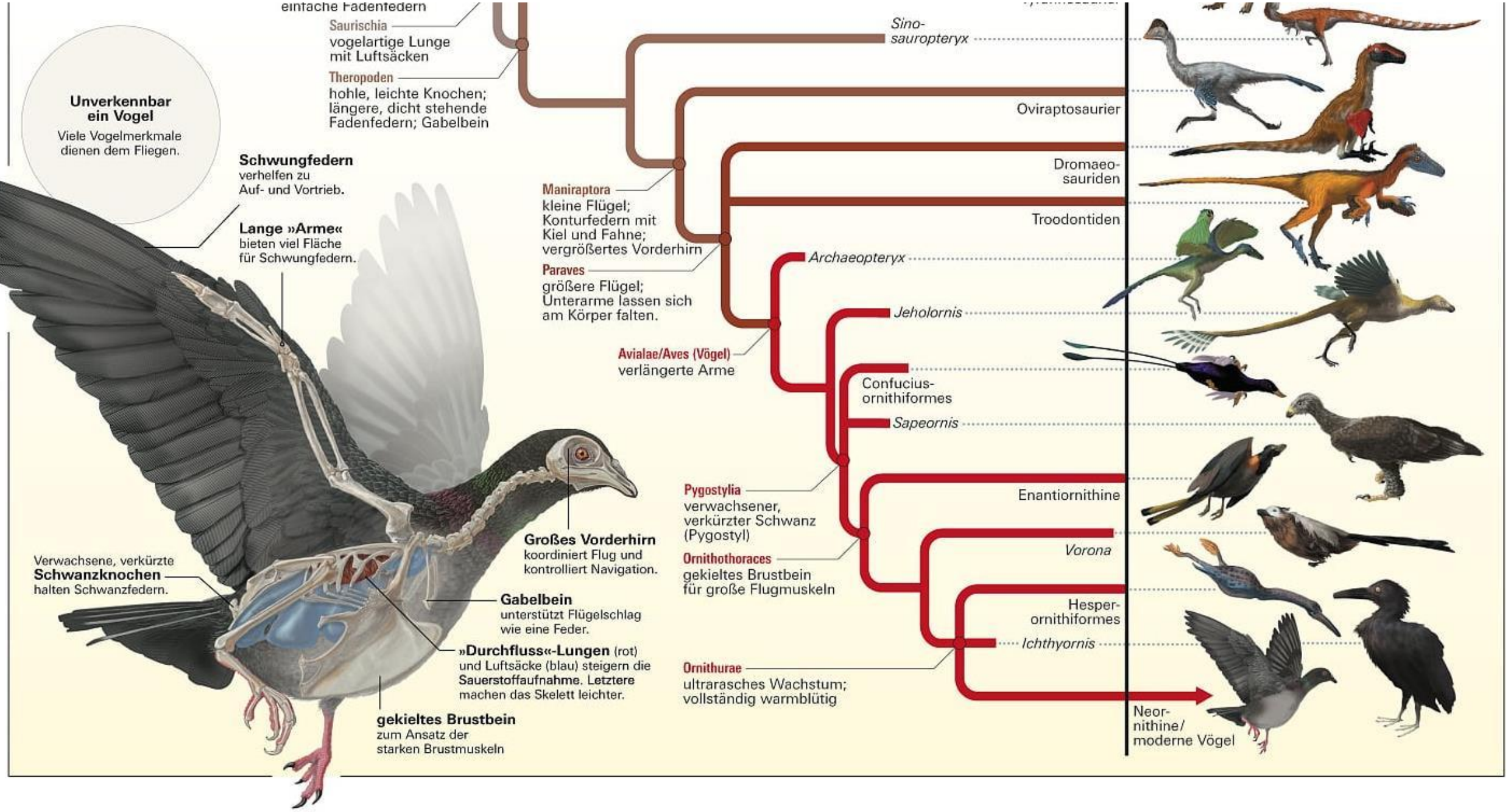
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Neor-nithine/ moderne Vögel
Schwungfedern
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Lange »Arme«
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halten Schwanzfedern.
Gabelbein
unterstützt Flügelschlag wie eine Feder.
»Durchfluss«-Lungen (rot) und Luftsäcke (blau) steigern die Sauerstoffaufnahme. Letztere machen das Skelett leichter.
gekieltes Brustbein
zum Ansatz der starken Brustmuskeln

Dinosaurier - Vögel

Dinosaurier:

- Ca. 1850 bisher beschriebene Arten
- 180 Millionen Jahre „Lebensdauer“
- Vor 65,5 Mio. Jahren ausgestorben
- Federkleid ist kein ausschliessliches Merkmal der Vögel

- Vögel:
- Ca. 11‘000 lebende Arten
- Existieren seit 150 Millionen Jahre
- Seit 65,5 Mio. Jahren weltweit verbreitet
- Vögel sind „fliegende Dinosaurier“

Krokodile: nächste heute noch lebende Verwandte der Vögel

Systematik der Vögel

Definitionen

Taxonomie: Arten beschreiben (Nomenklatur)

Systematik: Arten und höhere Einheiten (Gattung, Familie etc.) einordnen (Klassifikation)

Phylogenese: evolutionäre («natürliche») Verwandtschaften eruieren (Phylogenetik) und visualisieren mit Stammbäumen (Phylogramm)

Klassifikation

- Um 1730 durch Linné begründet: 7 Rangstufen
- Art – Gattung – Familie – Ordnung – Klasse – Stamm – Reich
- Art – Gattung – Familie sind von unten her aufgebaut (Arten werden zusammengefasst)
- Reich – Stamm – Klasse sind von oben her definiert (getrennt durch Lücken)
- Ordnung ist ein Zwischentaxon, das von unten wie von oben definiert wird

Deskriptive Anatomie

- Beschreibung und Vergleich von Formen und Strukturen
- Ähnlichkeiten können täuschen:
- Homologien beruhen auf Ähnlichkeit gleicher Abstammung
- Analogien beruhen auf Ähnlichkeit gleicher Anpassung - Konvergenzen

41. Ordnung der Aves:
MEROPES = BIENENFRESSER

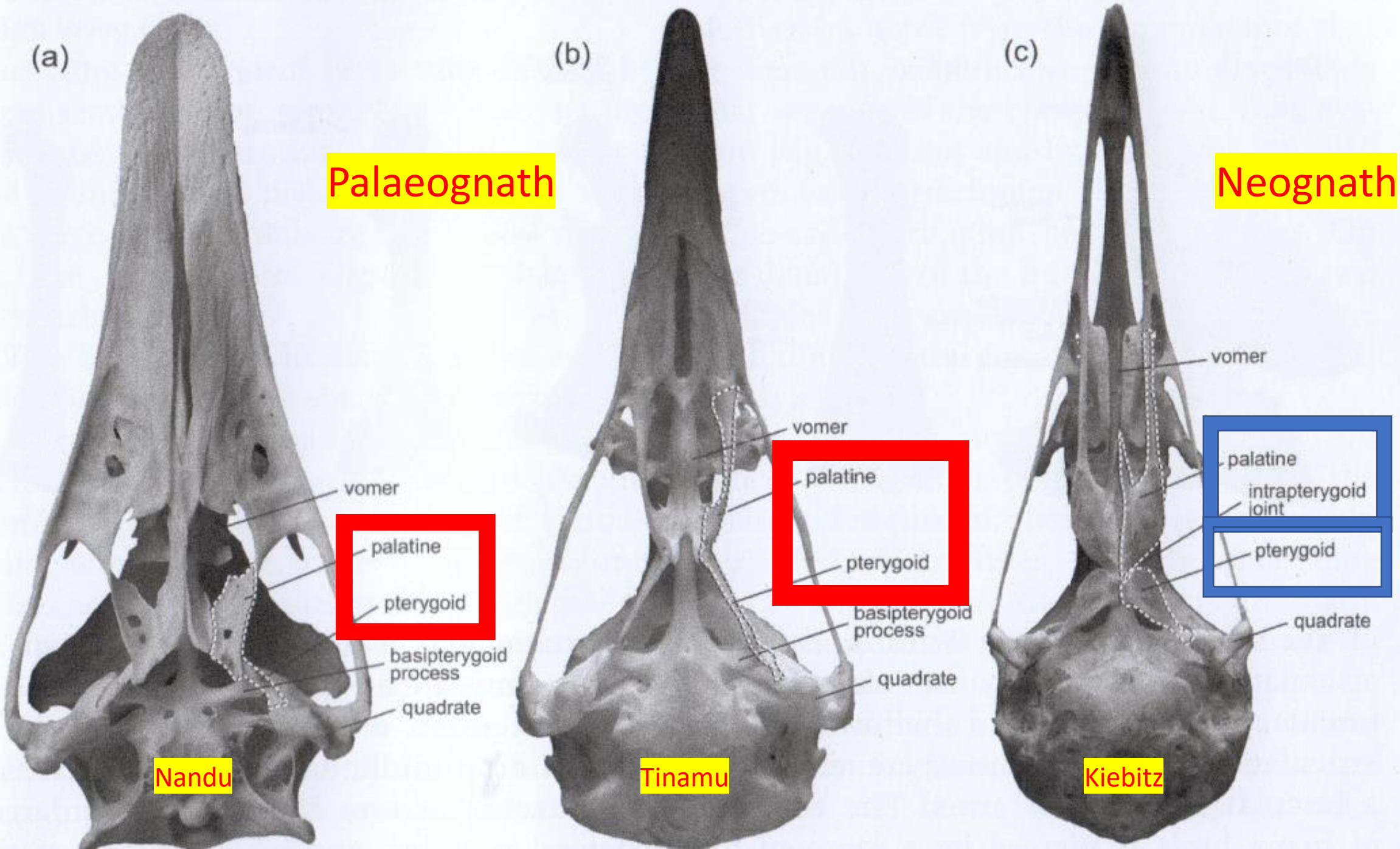
Die Bienenfresser bilden eine kleine, altweltliche Gruppe von Insecten-Fressern mit langem Schnabel und buntem Gefieder, die sich ihrer Beute *nach Schwalbenart* in langsamem Gleitflug bemächtigen (*ausgenommen* die relativ stumpfflügelige Gattung *Nyctiornis*, die die Insecten vorwiegend von Blüten und Blättern abliest). *Die Geschlechter* sind gleichgefärbt. Die weißen Eier (bis zu 6 im Gelege) werden stets am Grunde langer, in sandiges Erdreich vorgetriebener Röhren abgelegt. Die Jungen sind, wie bei *den Halcyones*, anfangs nackt und später wie mit Stacheln bedeckt. Die Bienenfresser kratzen sich den Kopf »hinten herum«. Gattungen: *Merops* Linnaeus, *Melittophagus* Boie, *Aërops* Reichenbach, *Dicrocercus* Cabanis & Heine, *Meropogon* Bonaparte, *Nyctiornis* Swainson (= *Bucia* Hodgson) *und andere*.

Struktur: Desmognath, holorhin, ohne Basipterygoid-Fortsätze. 14 Halswirbel. Metasternum mit 2 Paar Einschnitten. 4 vollständige Rippen-Paare. Fuß syndaktyl in derselben Weise wie bei *den Halcyones* (Grabwerkzeug!). Kein Musculus ambiens. Nur linke tiefe Carotis (*außer Nyctiornis*). Blinddärme lang, wie bei *den Coraciae*. Deckfedern mit Afterschaft. Handschwingen 10 + 1 (*Nyctiornis und Merops* nur 10). Steuerfedern 12. Flügel eutaxisch. Bürzeldrüse nackt.

Stellung im System: Wohl an *die Coraciae und Halcyones* anzuschließen, vielleicht auch zu *den Upupae* überleitend.

42. Ordnung der Aves:
MOMOTI = SÄGERACKEN

Eine kleine Gruppe neuweltlicher Baumvögel, die ihren Verbreitungsschwerpunkt


(a)
Palaeognath
vomer
palatine
pterygoid
basipterygoid process
quadrate
Nandu
(b)
vomer
palatine
pterygoid
basipterygoid process
quadrate
Tinamu
(c)
Neognath
vomer
palatine
intrapterygoid joint
pterygoid
quadrate
Kiebitz

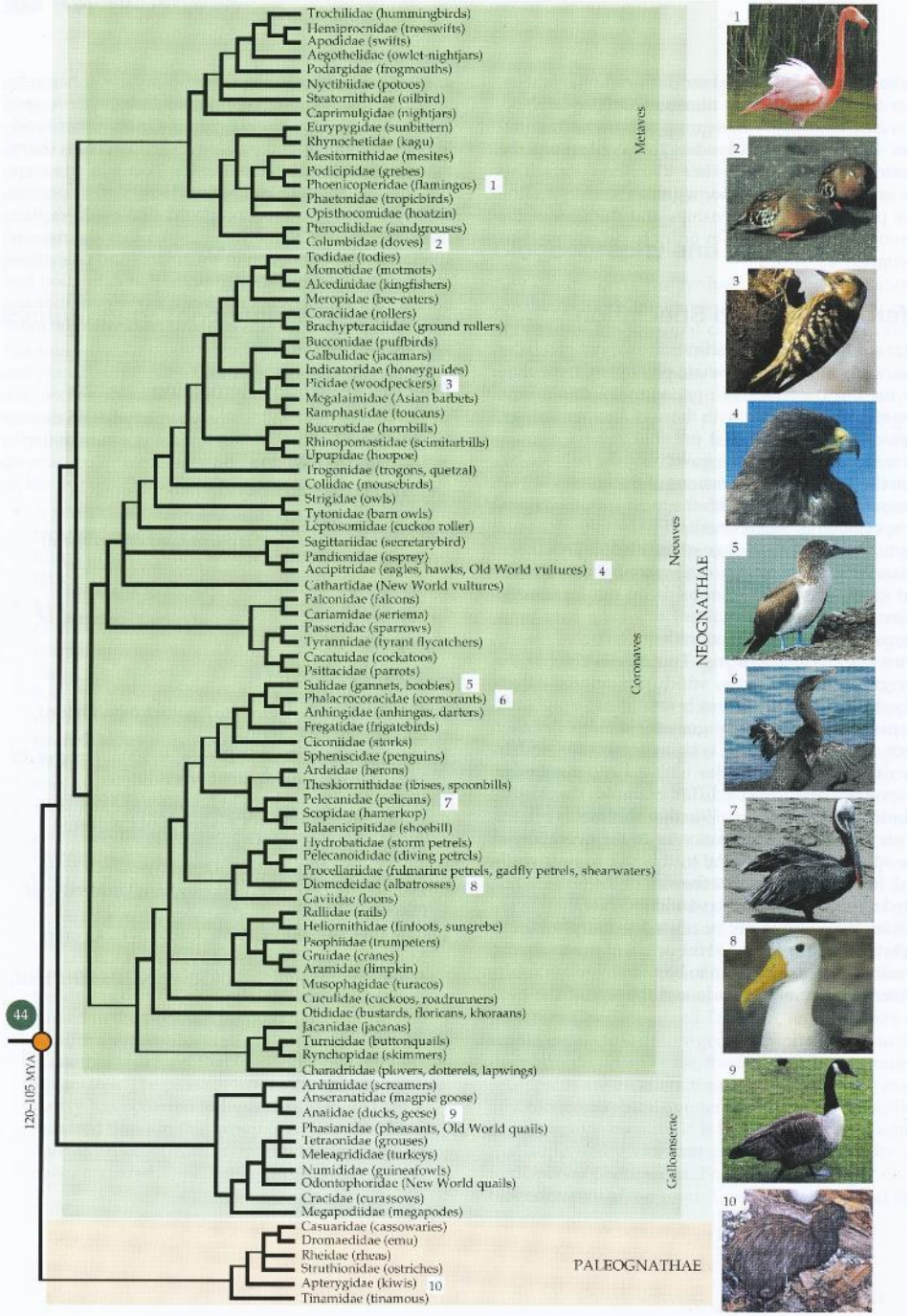
Sapayoa aenigma

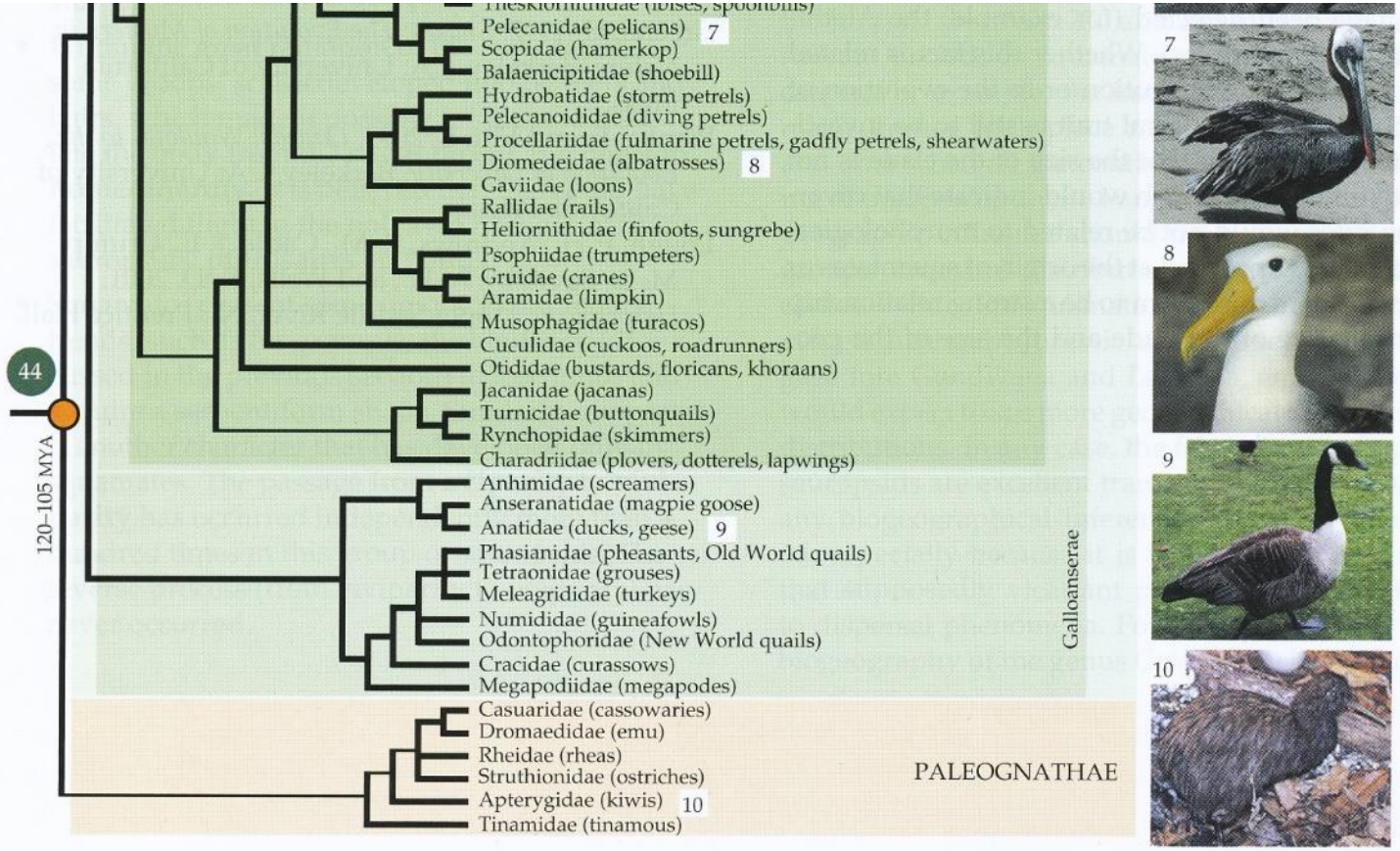
Grünpipra Cryptopipa holochlora

Sapayoa Nester

Langschwanz-Breitrachen

Molekulargenetische Analyse: Phylogramm evolutiver Verwandtschaft Kalibrierung mittels Mutationsrate





Avian Phylogenomics Project 2014: 48 Vogelarten sequenziert

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RESEARCH ARTICLE

Whole-genome analyses resolve early branches in the tree of life of modern birds

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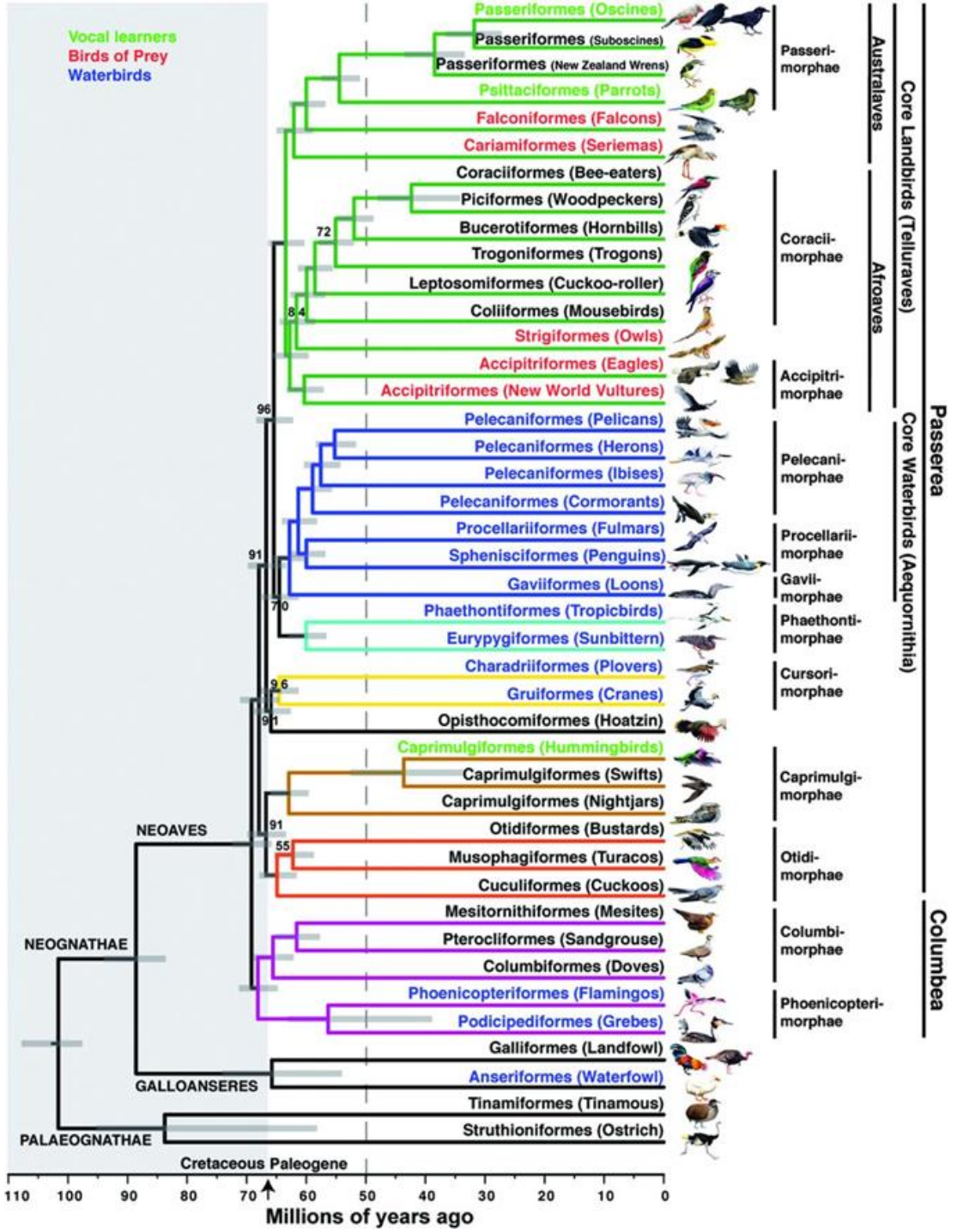
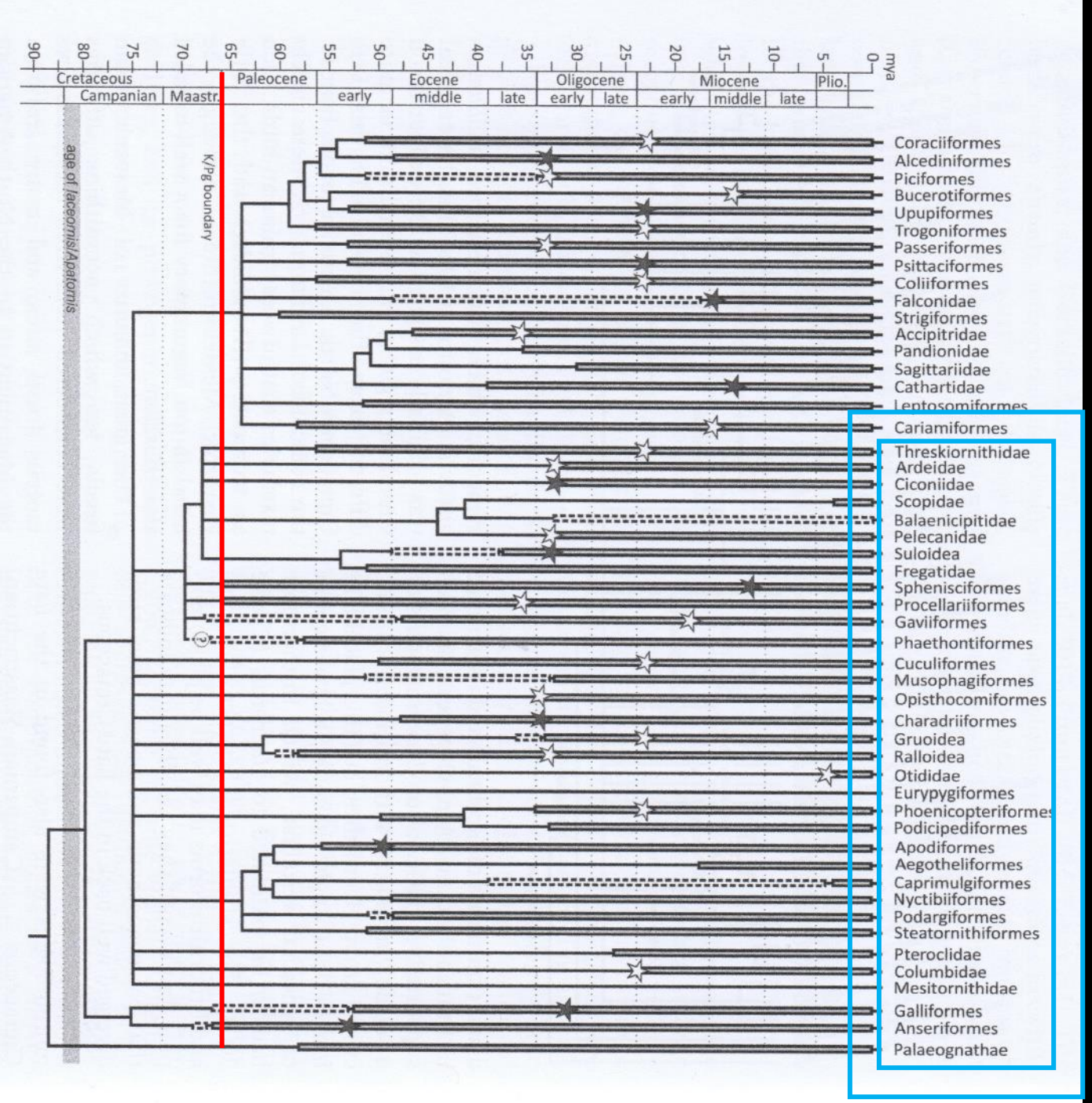
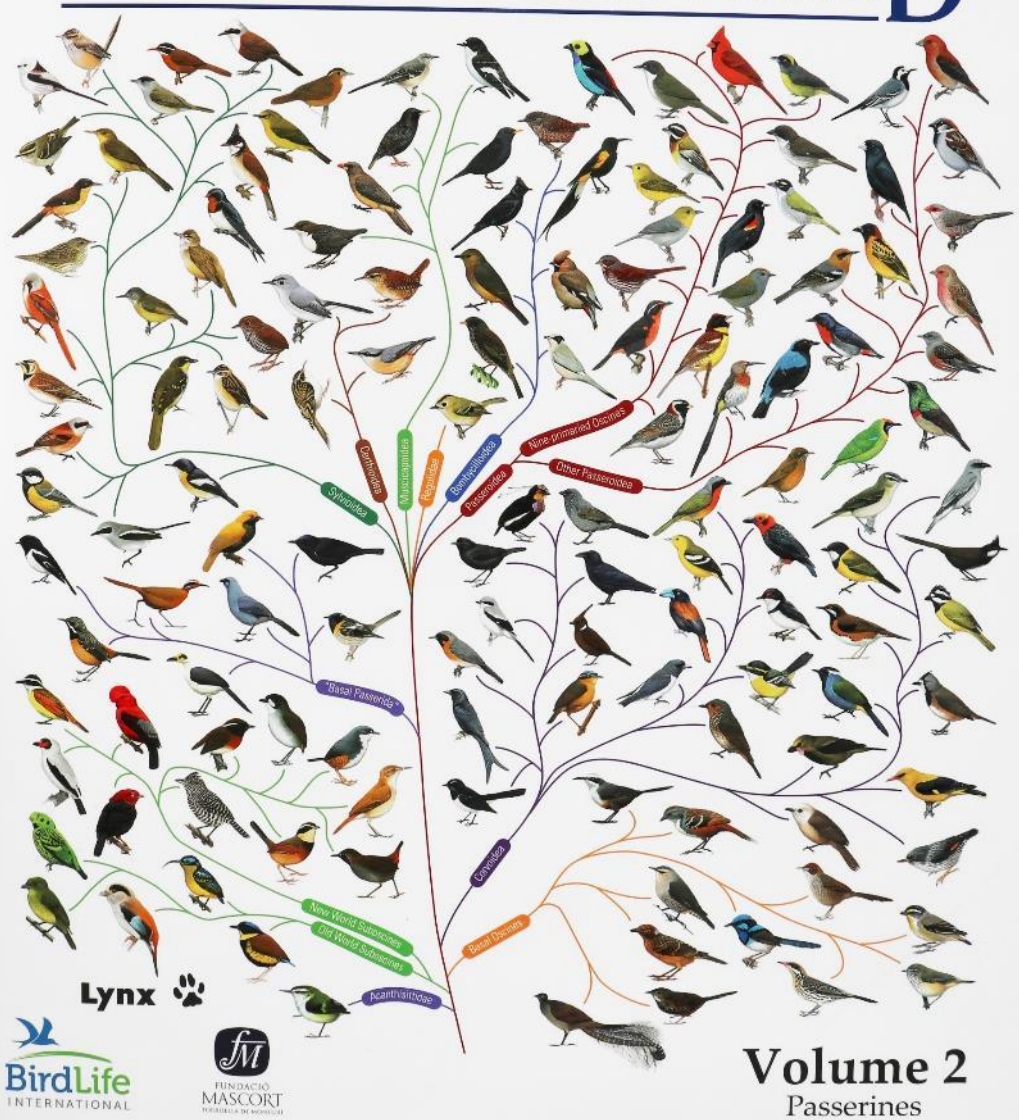




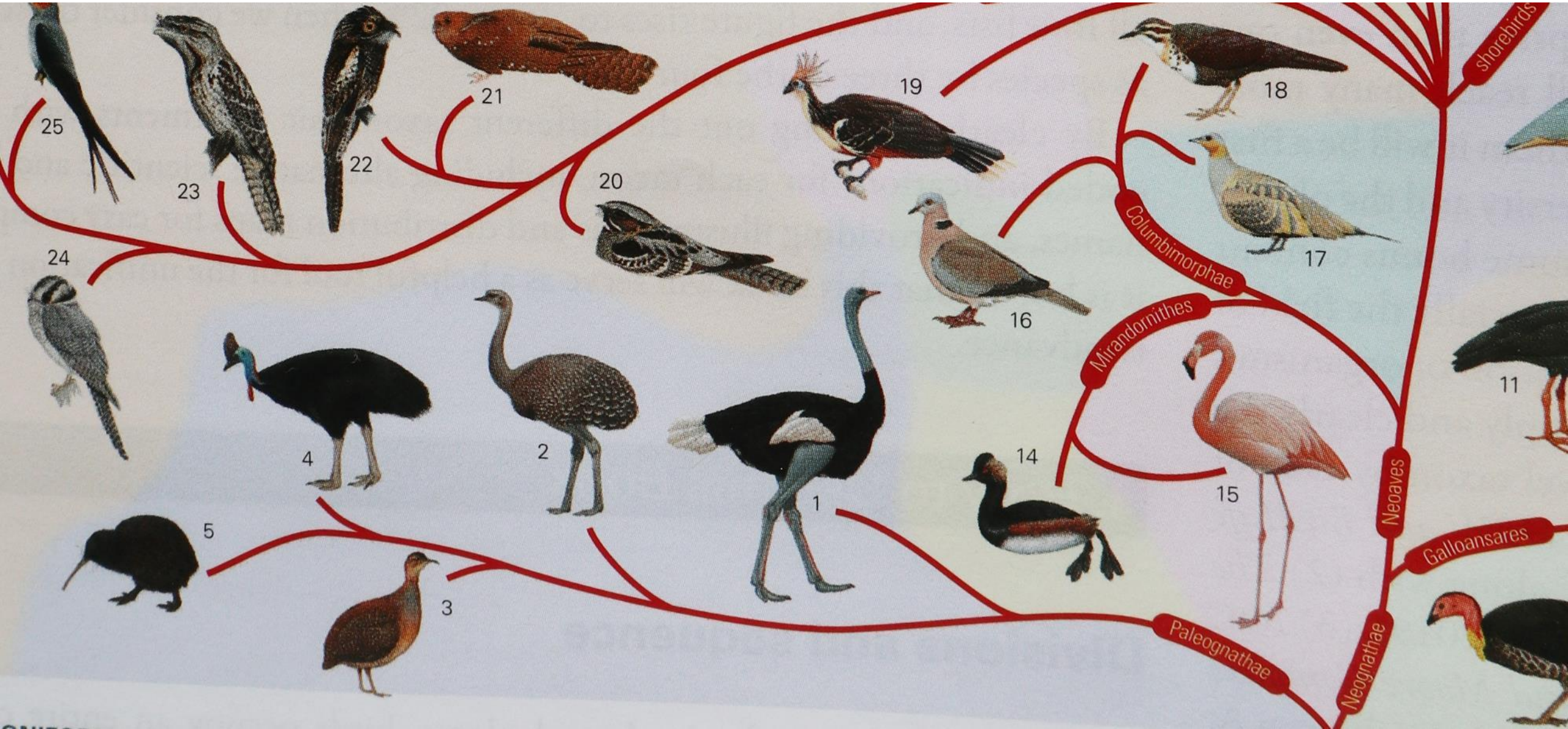
Alle diese Vogelgruppen haben ihren Ursprung noch im Zeitalter der Dinosaurier (Mayr 2017)

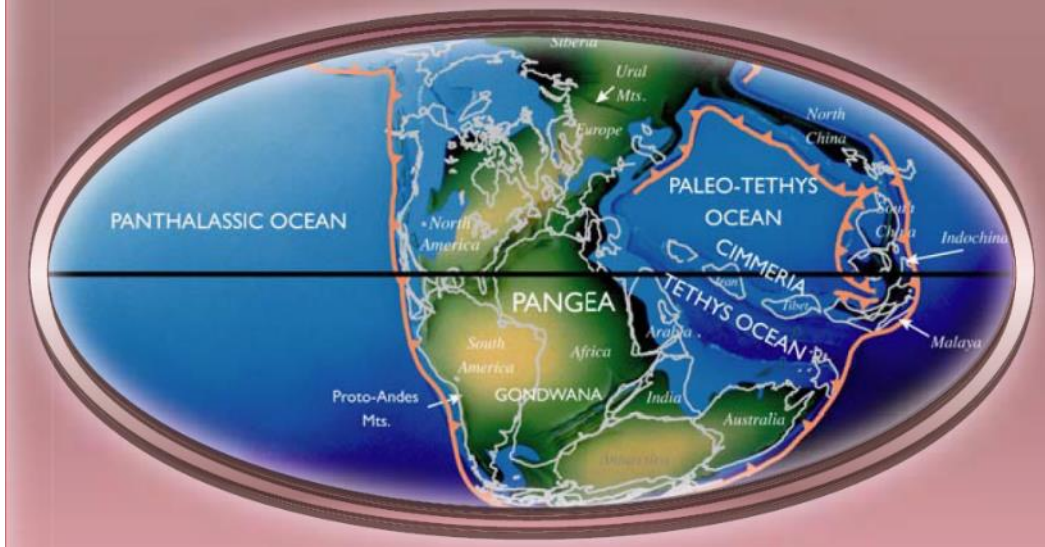
Nicht-Sperlingsvögel:
35 Ordnungen mit 105 Familien
988 Genera mit 4372 Arten

Sperlingsvögel:
1 Ordnung mit 147 Familien
1358 Genera mit 6592 Arten

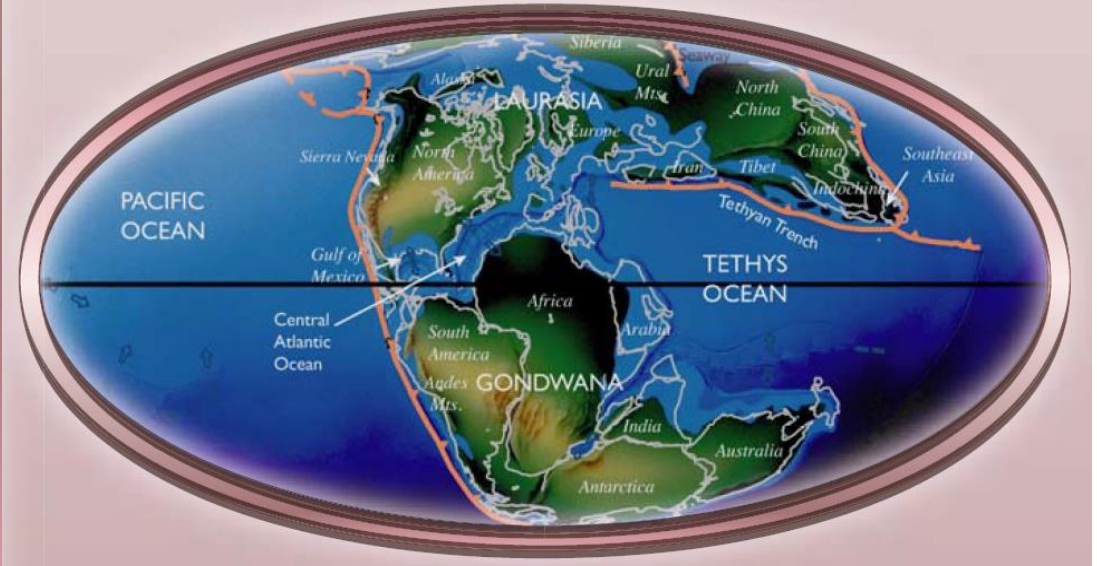


Palaeognathae-Neognathae, Mirandornithes

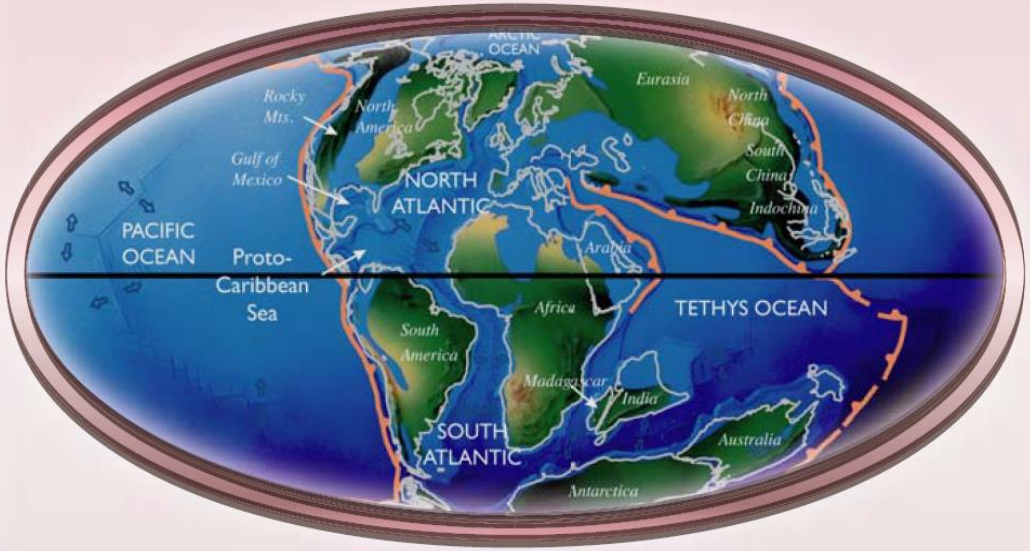




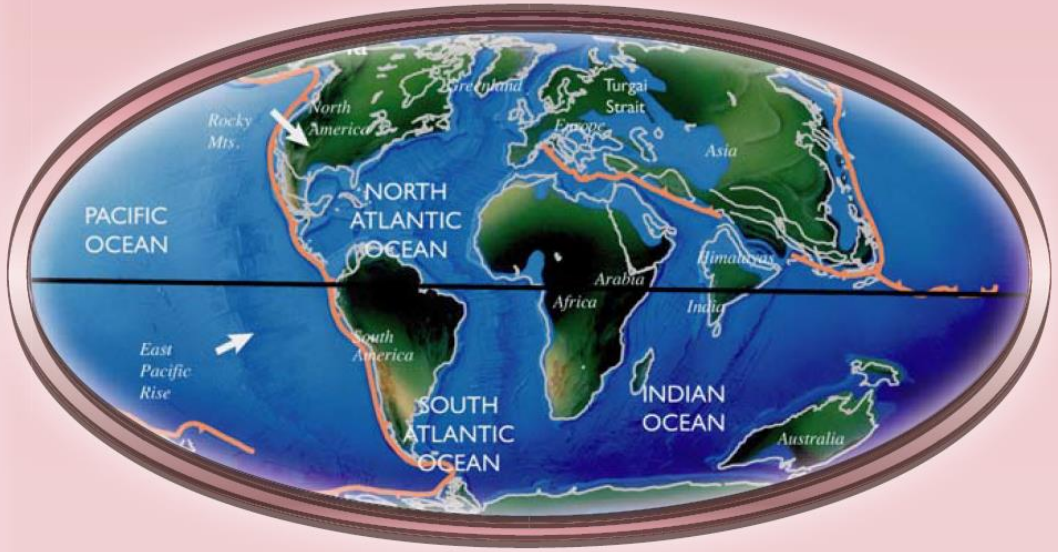
237 Ma Triassic



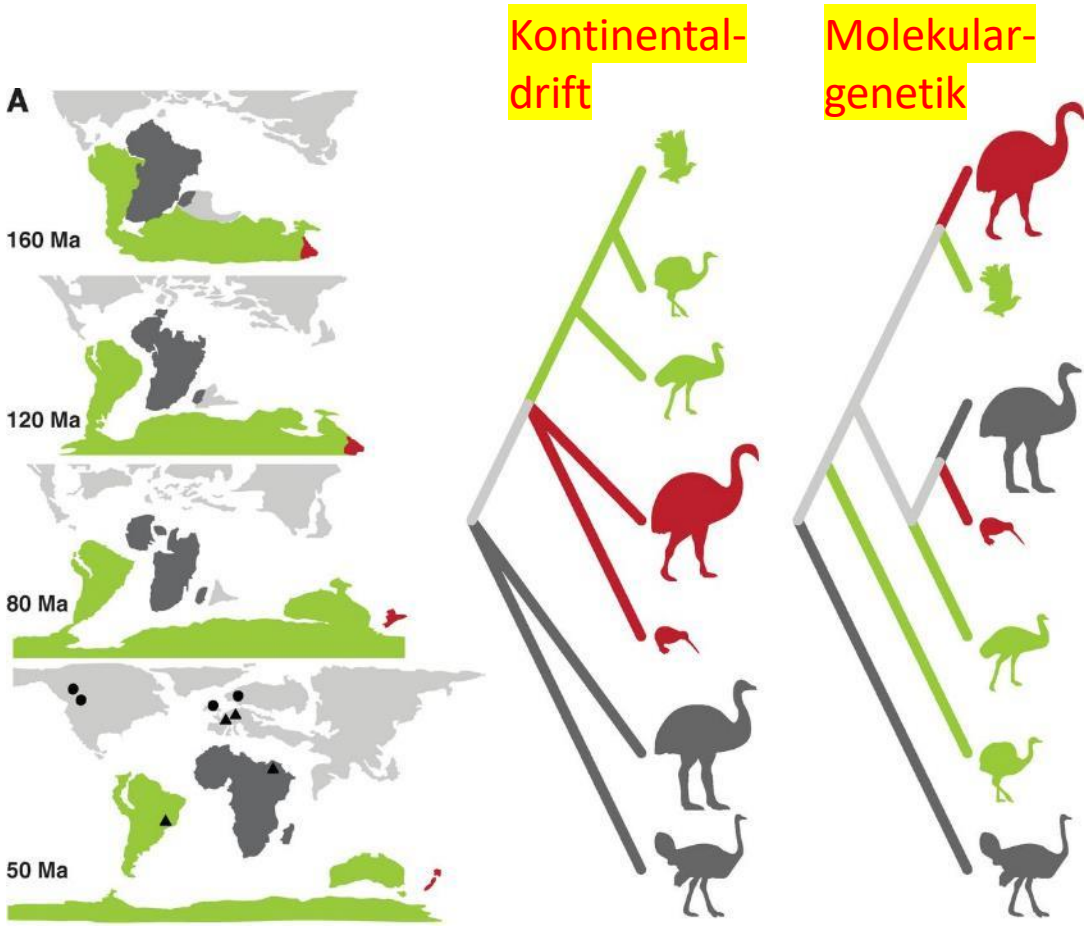
152 Ma Jurassic

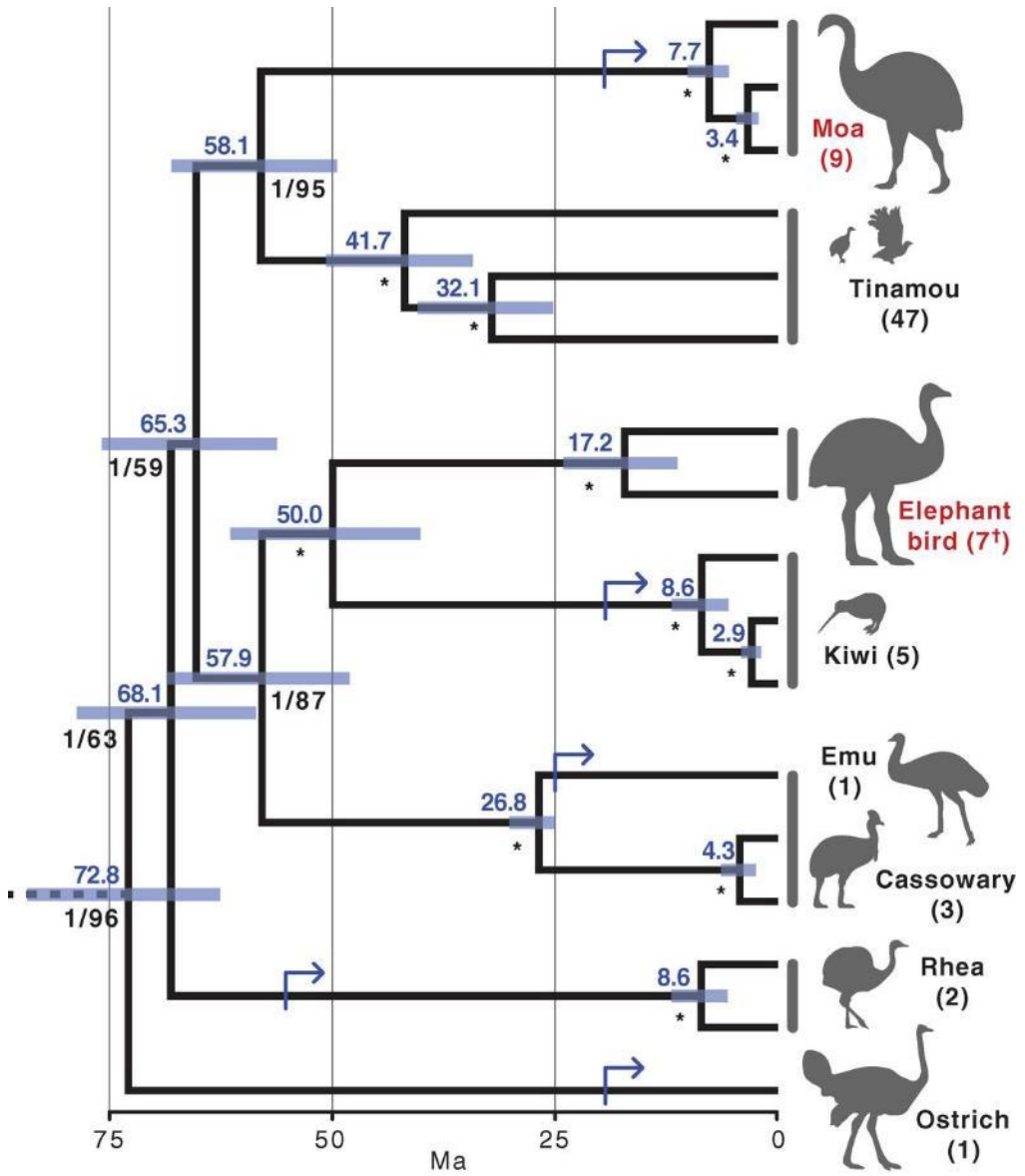


94 Ma Cretaceous

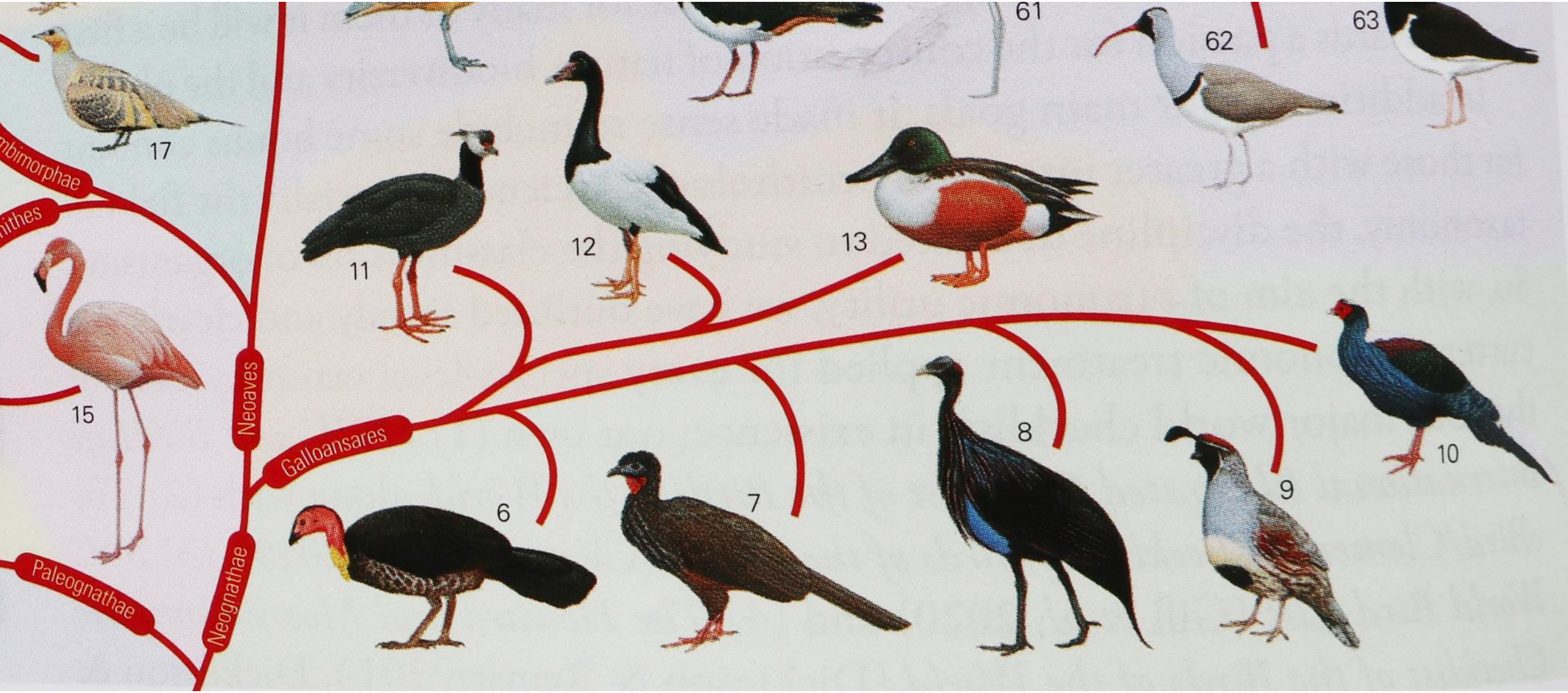


50 Ma Paleogene

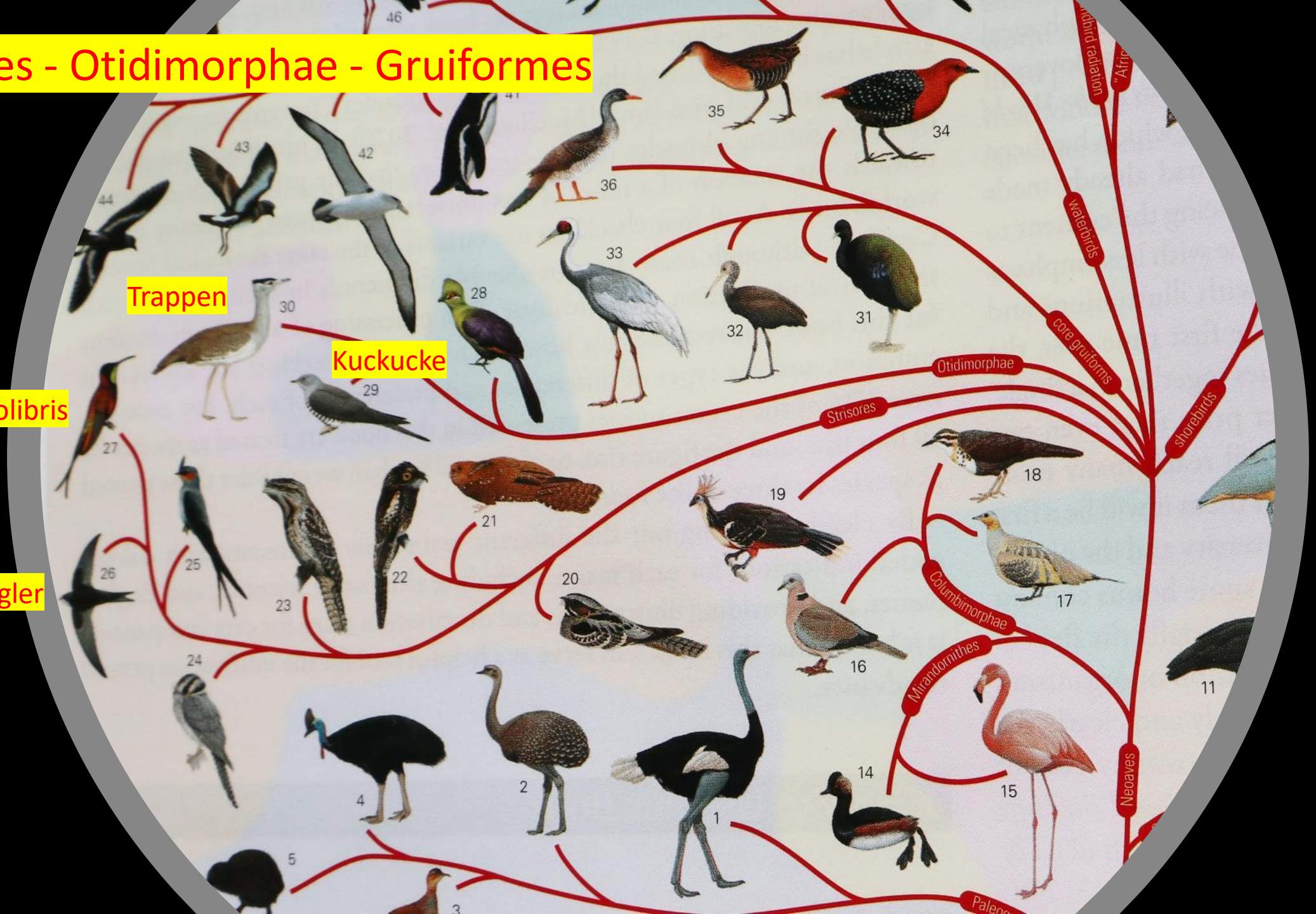

A
160 Ma
120 Ma
80 Ma
50 Ma
Kontinental-
drift
Molekular-
genetik

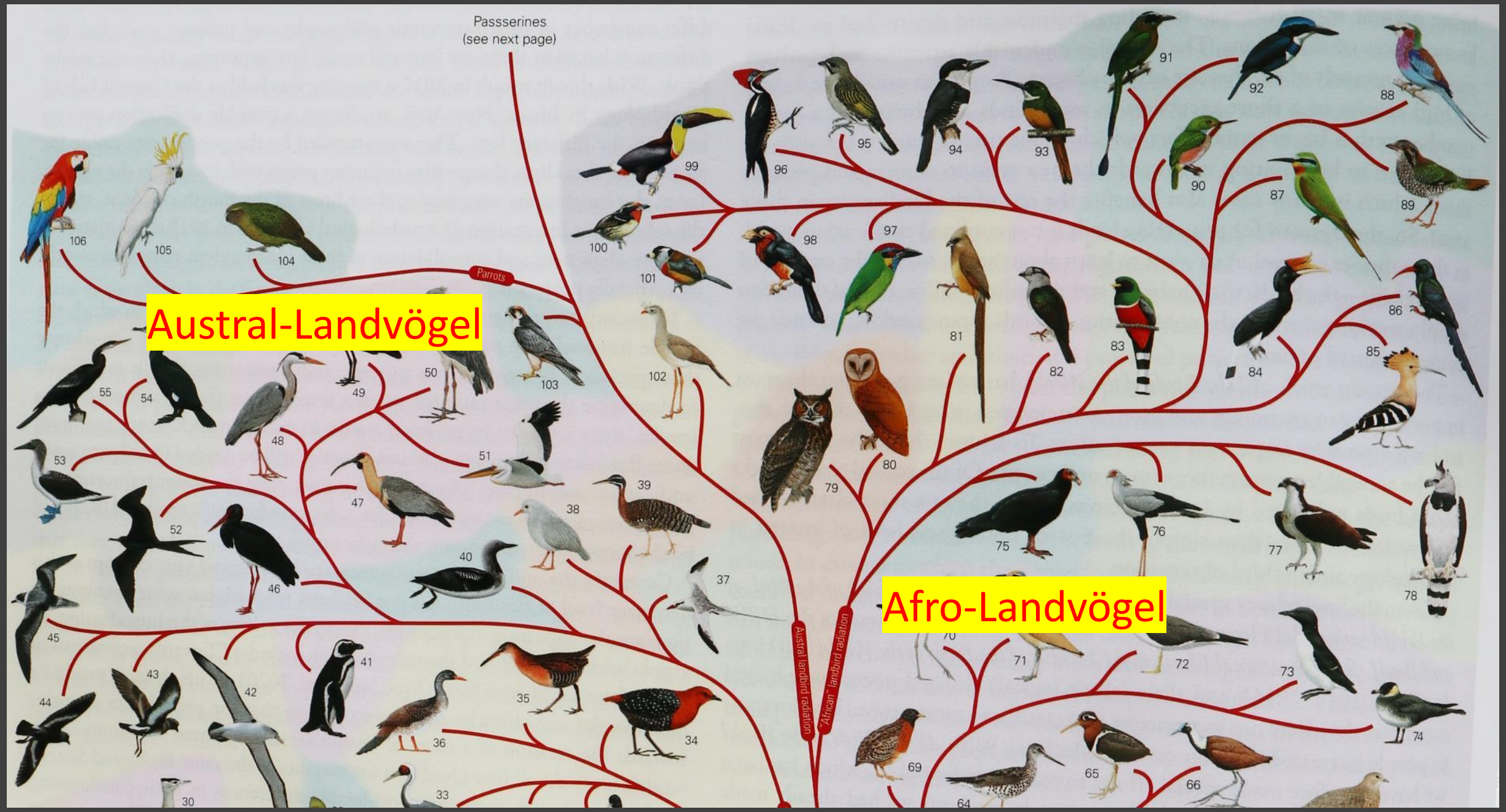

7.7
3.4
Moa
(9)
58.1
1/95
41.7
32.1
Tinamou
(47)
65.3
1/59
17.2
50.0
Elephant
bird (7†)
8.6
2.9
Kiwi (5)
57.9
1/87
68.1
1/63
Emu
(1)
26.8
4.3
Cassowary
(3)
72.8
1/96
8.6
Rhea
(2)
Ostrich
(1)
75
50
25
0
Ma

Galloanseres



Strisores - Otidimorphae - Gruiformes




Passserines
(see next page)
Parrots
Austral-Landvögel
Afro-Landvögel
Austral landbird radiation
"African" landbird radiation

Passeriformes

Unterordnung Acanthisitti

Unterordnung Tyranni

Unterordnung Passeri=Singvögel

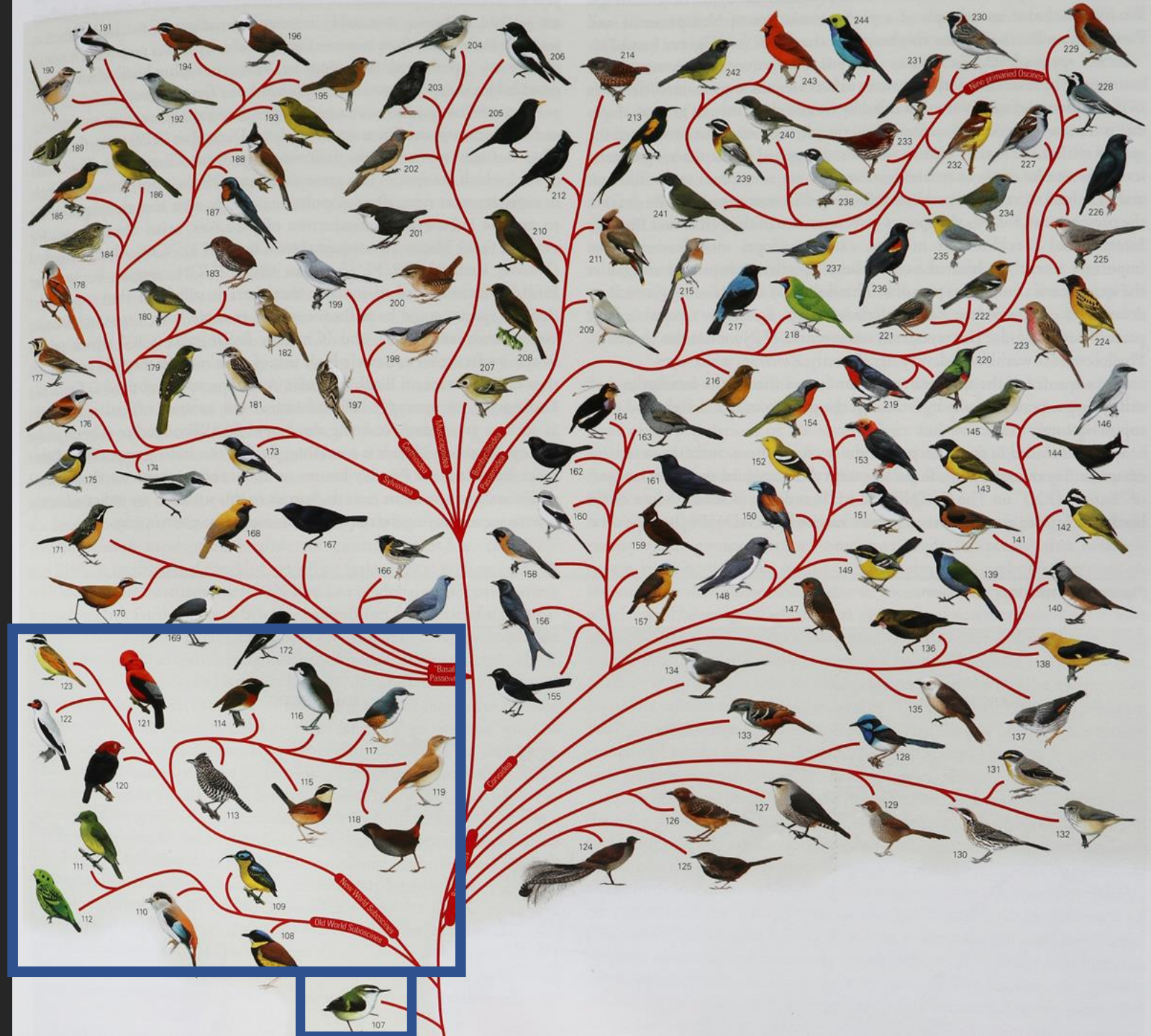


Figure 1.4. Principal colonization routes by oscine passerine birds around the world. The map shows the outline of continents and the position of oceanic island arcs around 30 million years ago.

The Largest Avian Radiation

The Evolution of Perching Birds, or the Order Passeriformes

Jon Fjeldså, Les Christidis & Per G. P. Ericson (editors)

Lynx

Vielen Dank
für eure
Aufmerksamkeit

Der Vortrag
wird als PDF
auf der Website
der AGEO
aufgeschaltet

Figure 1.1. The phylogeny of the major groups of birds, based on the first genome-level analysis of these groups (Jarvis *et al.* 2014; Houde *et al.* 2019; Kimball *et al.* 2019). The branch lengths are time-proportional, with the origin (100 million years ago) in the centre and most of the bird orders diverging from around 65 Mya. Coloured branches identify three major groups of modern birds: the aquatic Aequornithes (in blue) and two major landbird radiations (Passerimorphae in red, Accipitrimorphae in yellow). The bird groups are, reading clockwise from the bottom, ostrich (order Struthioniformes), tinamou (Tinamiformes), waterfowl (Anseriformes), turkey and chicken (Galliformes), grebe and flamingo (Phoenicopteriformes), pigeon (Columbiformes), sandgrouse (Pteroclidiformes), mesite (Mesitornithiformes), turaco (Musophagiformes), bustard (Otidiformes), cuckoo (Cuculiformes), nightjar, swift and hummingbird (Caprimulgiformes), hoatzin (Opisthocomiformes), plover (Charadriiformes), crane (Gruiformes), tropicbird (Phaethontiformes), sunbittern (Eurypygiformes), diver (Gaviiformes), fulmar (Procellariiformes), two penguins (Sphenisciformes), cormorant, pelican, crested ibis and heron (Pelecaniformes), seriema (Cariamiformes), falcon (Falconiformes), kea and budgerigar (Psittaciformes), five passerines, niltava, manakin, raven, zebra finch and a Galapagos finch (Passeriformes), turkey vulture and two sea eagles (Accipitriformes), barn owl (Strigiformes), mousebird (Coliiformes), cuckooroller (Leptosomatiformes), trogon (Trogoniformes), hornbill (Bucerotiformes), woodpecker (Piciformes) and bee-eater (Coraciiformes).