

THE TITMOUSE STORY

How did 2 titmice species get to
Travis County, Texas
From Australia in
~47 million years ?

▶ Short Answer:

▶ Change over time, selection, dispersal

▶ Long Answer:

▶ Change over time, selection, dispersal

THE TREE OF LIFE

TITMICE

CLASSIC (LINNEAN) TAXONOMY

► **Domain:** Eukarya

► **Kingdom:** Animalia

► **Phylum:** Chordata

► **Class:** Aves

► **Order:** Passeriformes

Family: Paridae

Genus: Baeolophus

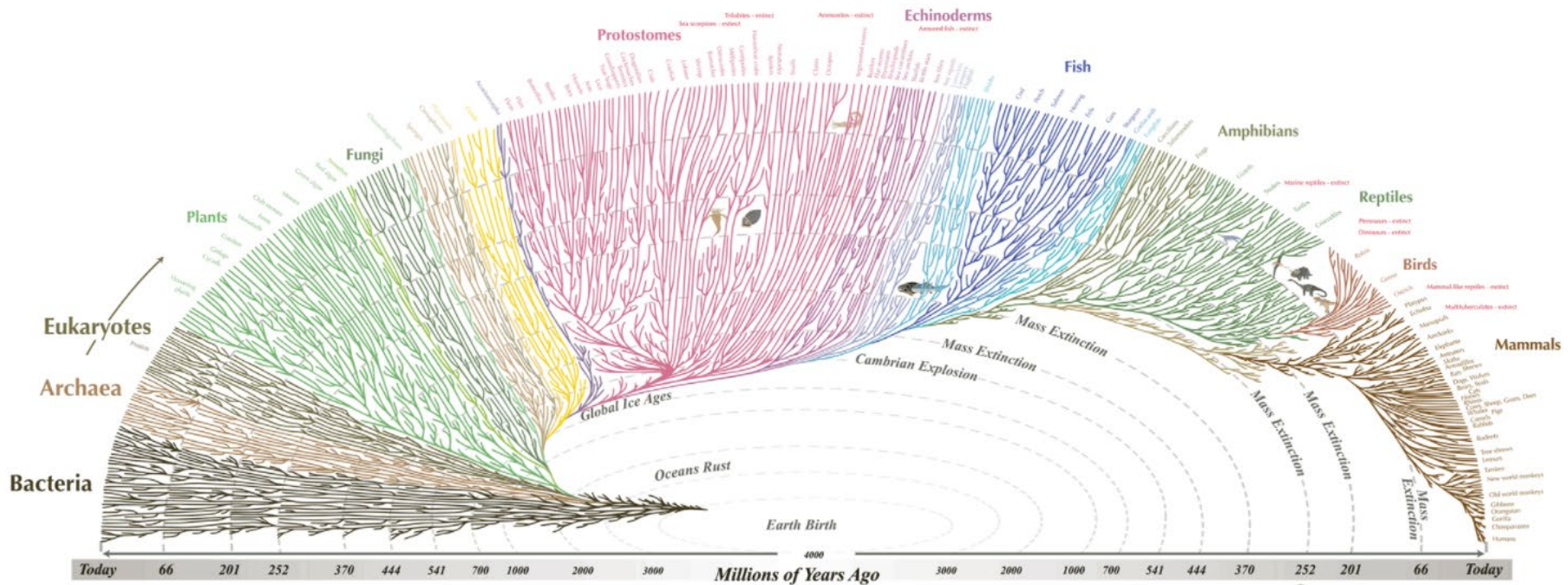
Species: atricristatus
bicolor

Doesn't reflect evolutionary history.

Do **K**ings **P**lay **C**hess **O**n **F**ine **G**reen **S**ilk?

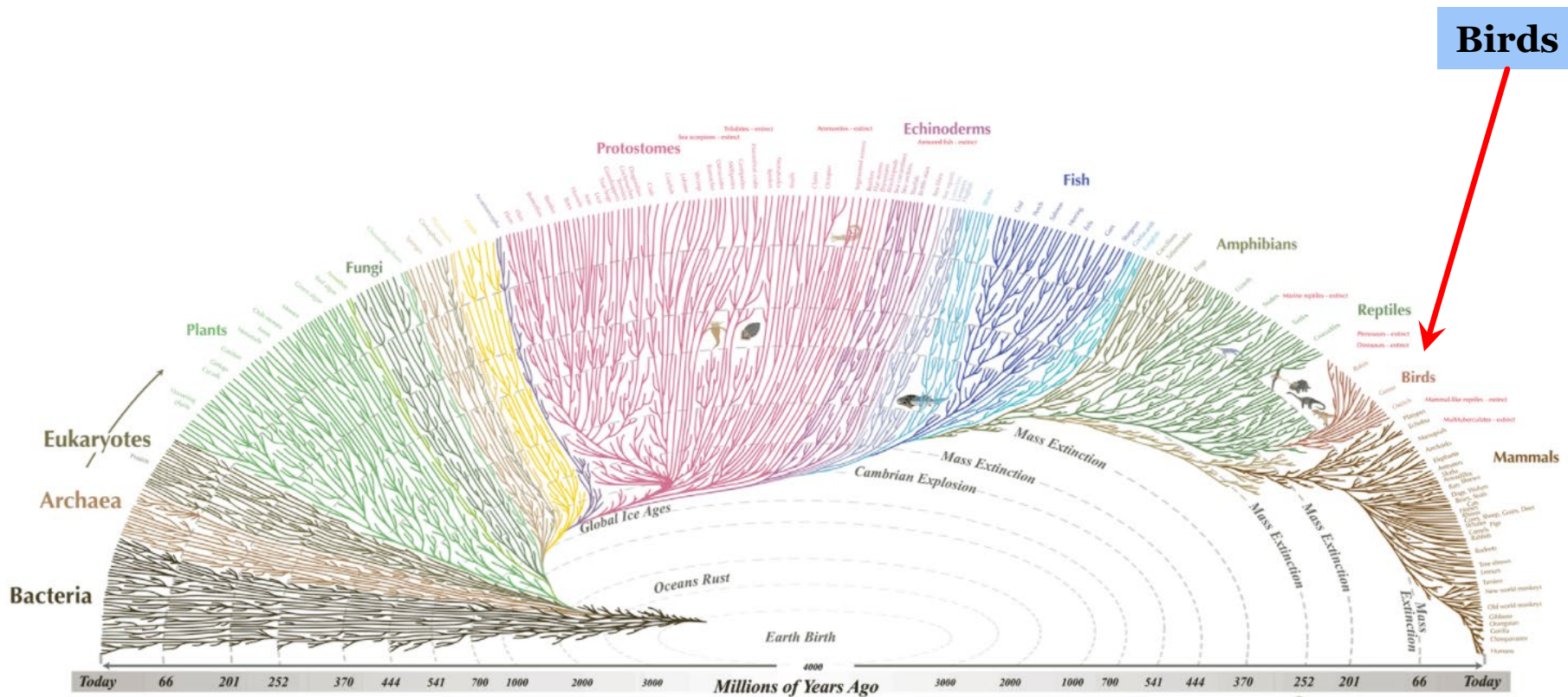
LIFE IS NOT
THAT SIMPLE !!

The Tree of Life
is much more
complex

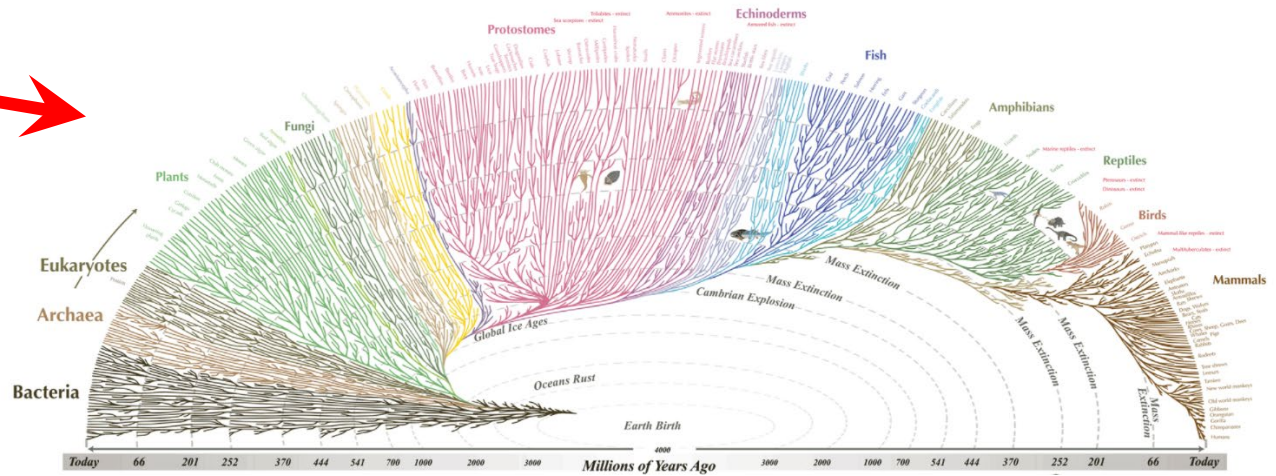


The Tree of Life is much more complex

Phylogeny – the science of evolutionary relationships.



How you gonna show this,



With this?

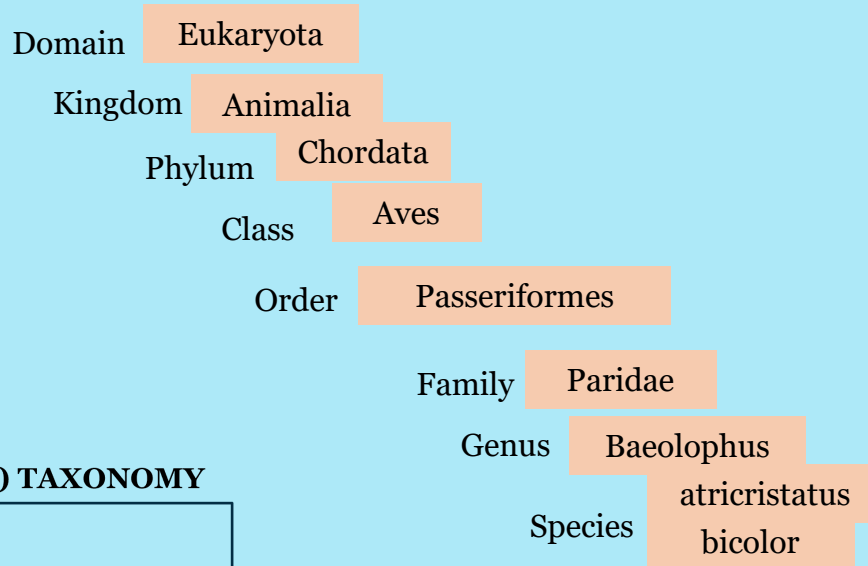


CLASSIC (LINNEAN) TAXONOMY

- ▶ **Domain:**
 - ▶ **Kingdom:**
 - ▶ **Phylum:**
 - ▶ **Class:**
 - ▶ **Order:**
 - ▶ **Family:**
 - ▶ **Genus:**
 - ▶ **Species:**

Do Kings Play Chess On Fine Green Silk?

LINEAGE OF TRAVIS COUNTY TITMICE

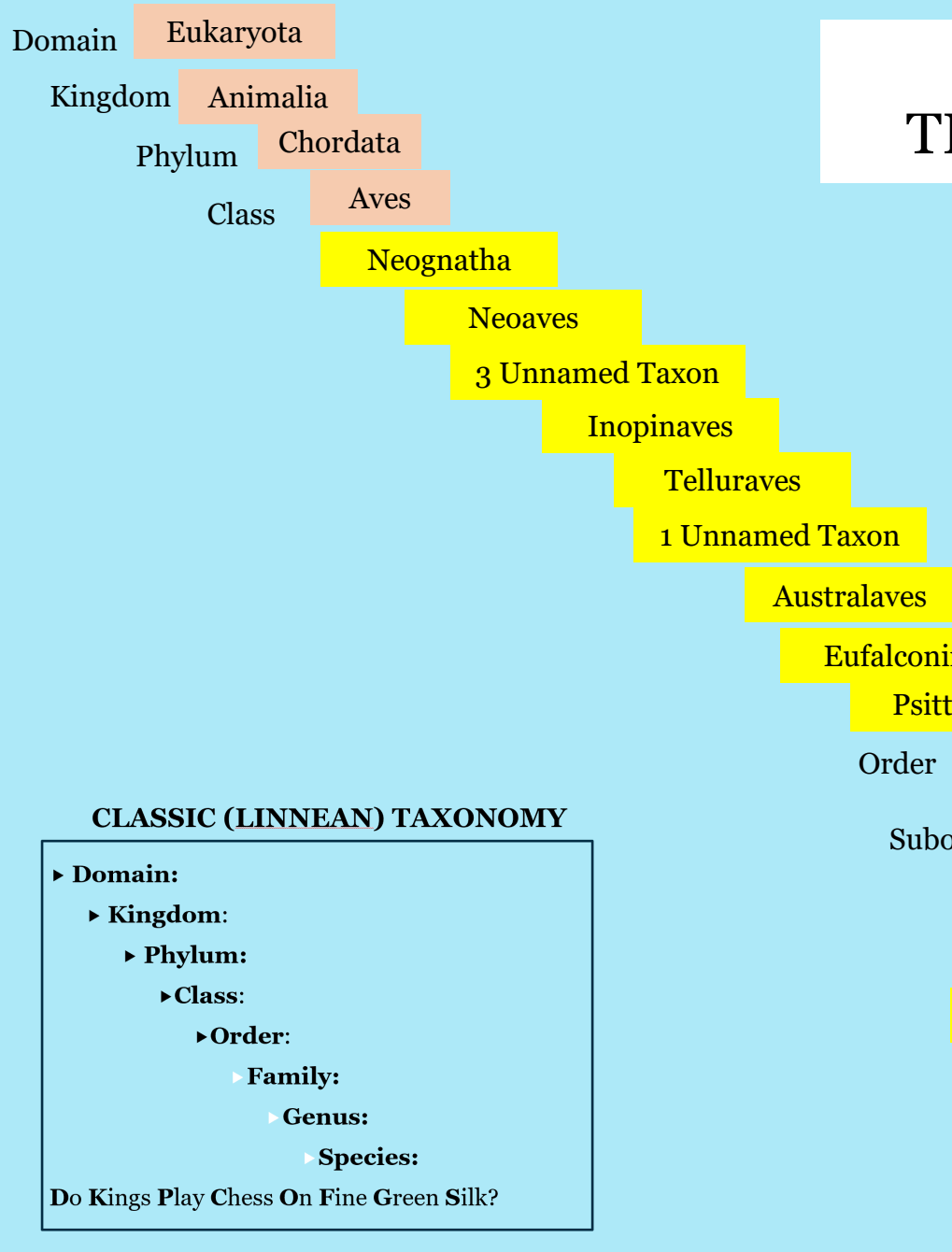


CLASSIC (LINNEAN) TAXONOMY

- ▶ **Domain:**
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Do Kings Play Chess On Fine Green Silk?

LINEAGE OF TRAVIS COUNTY TITMICE



New ranks are added as justified. In accordance with nomenclature rules.

CLASSIC (LINNEAN) TAXONOMY

- ▶ **Domain:**
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 - ▶ **Family:**
 - ▶ **Genus:**
 - ▶ **Species:**
- Do Kings Play Chess On Fine Green Silk?

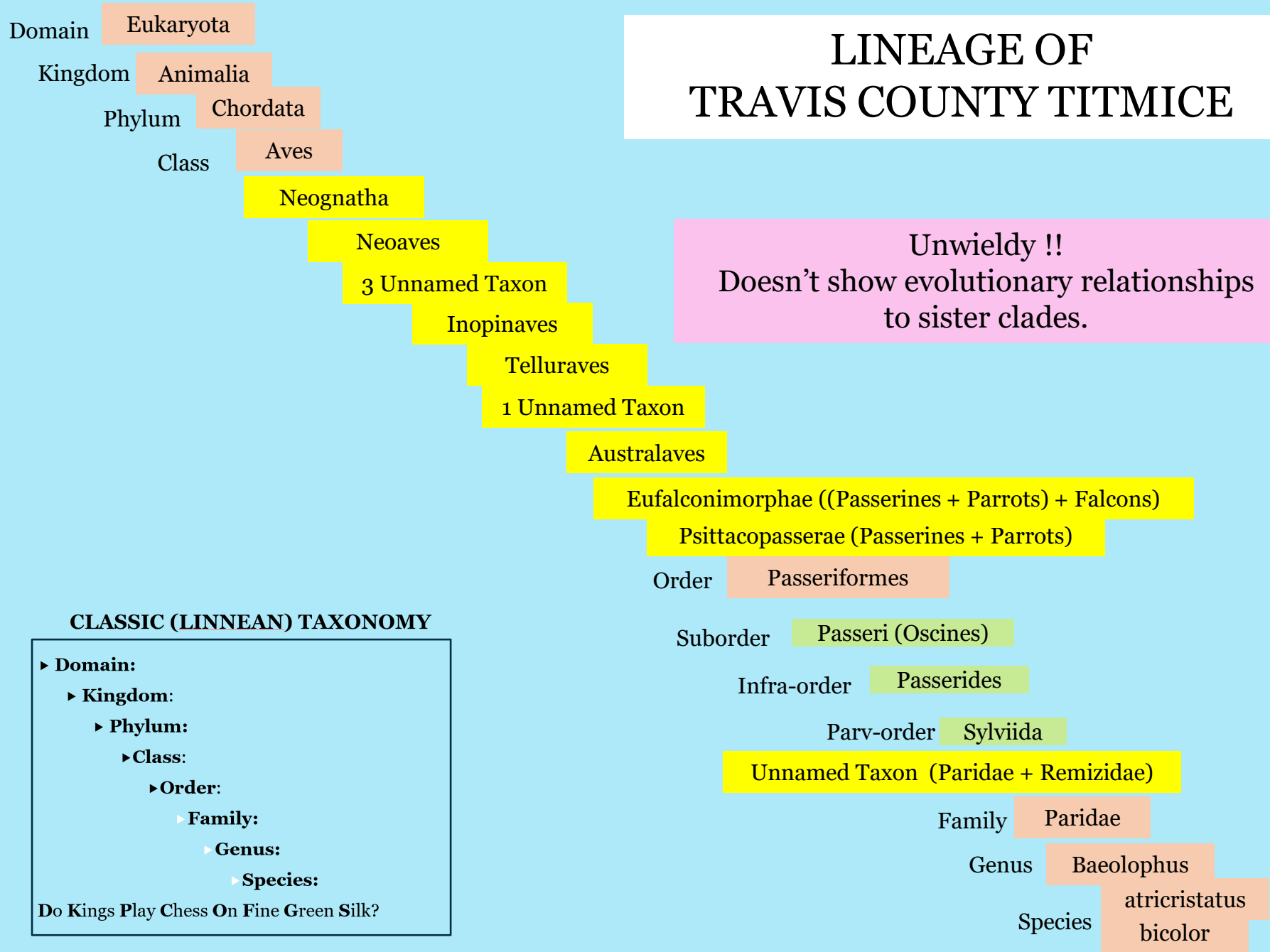
Unnamed Taxon (Paridae + Remizidae)

Family: Paridae

Genus: Baeolophus

Species: atricristatus bicolor

LINEAGE OF TRAVIS COUNTY TITMICE



CLASSIC (LINNEAN) TAXONOMY

- ▶ **Domain:**
 - ▶ **Kingdom:**
 - ▶ **Phylum:**
 - ▶ **Class:**
 - ▶ **Order:**
 - ▶ **Family:**
 - ▶ **Genus:**
 - ▶ **Species:**
- Do Kings Play Chess On Fine Green Silk?

WHAT'S A CLADOGRAM ? WHAT'S A CLADE?

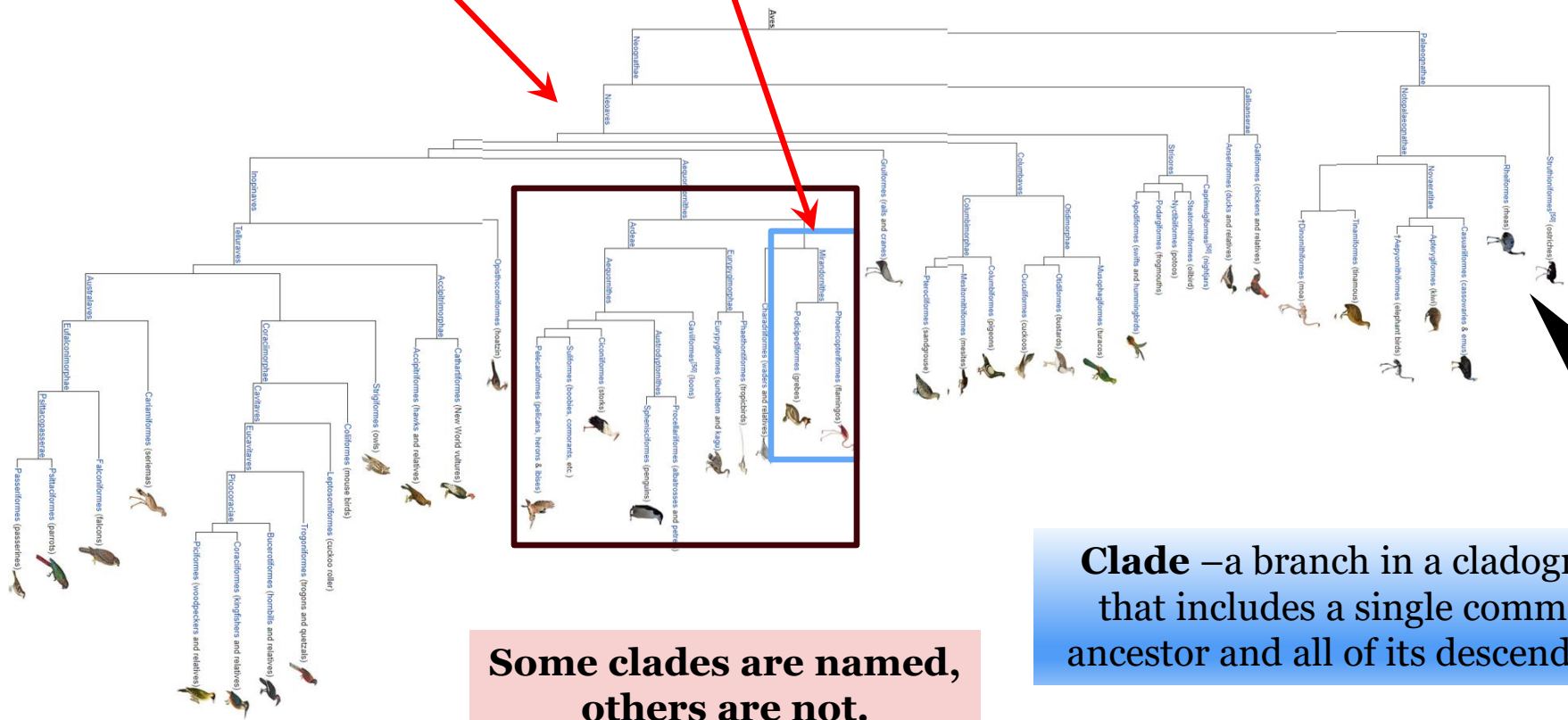
Cladogram – lines show history of shared ancestry.

Each branch is a speciation event

Clade 2

Clade 1

TIME

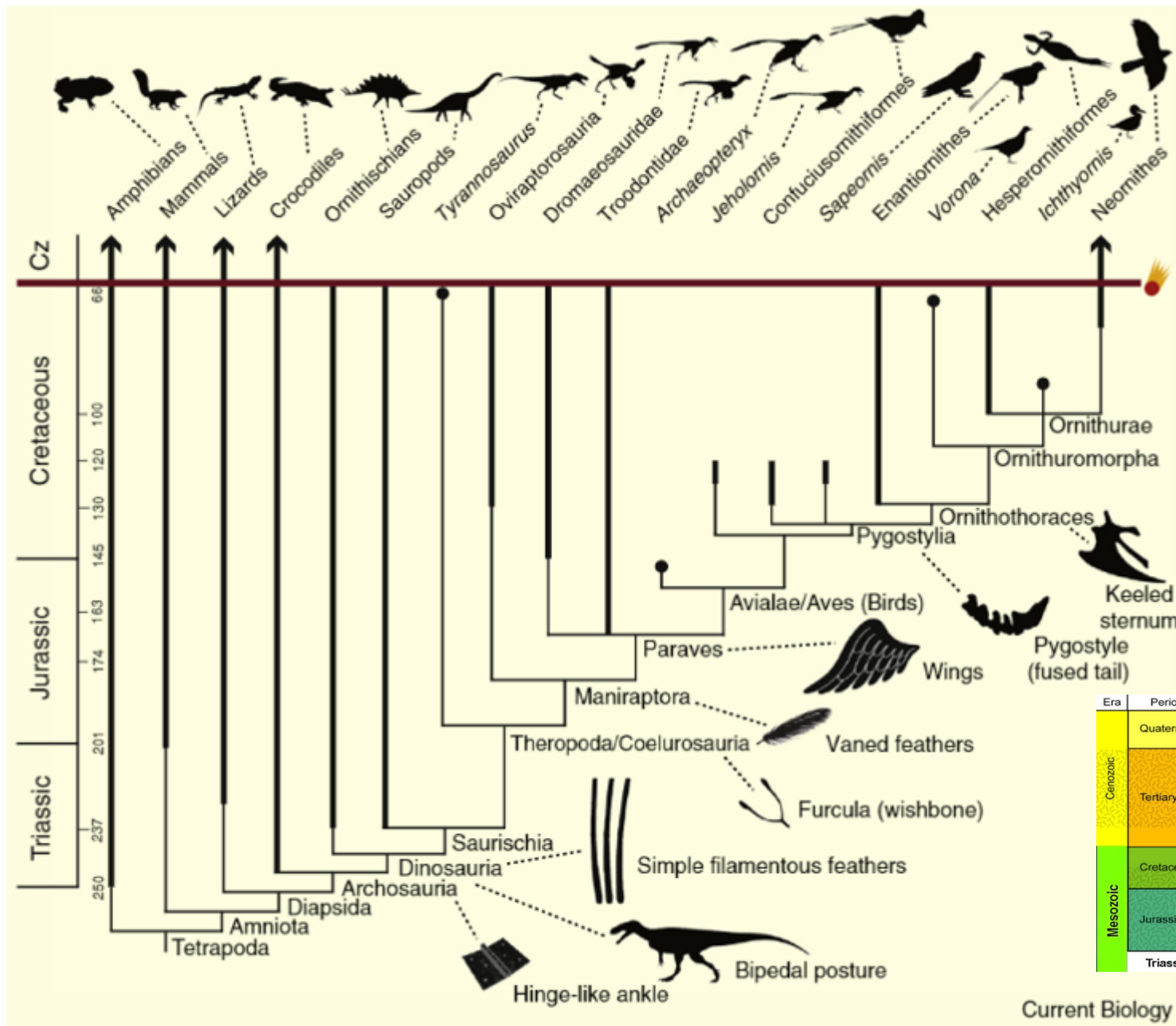


Some clades are named, others are not.

Clade – a branch in a cladogram that includes a single common ancestor and all of its descendants

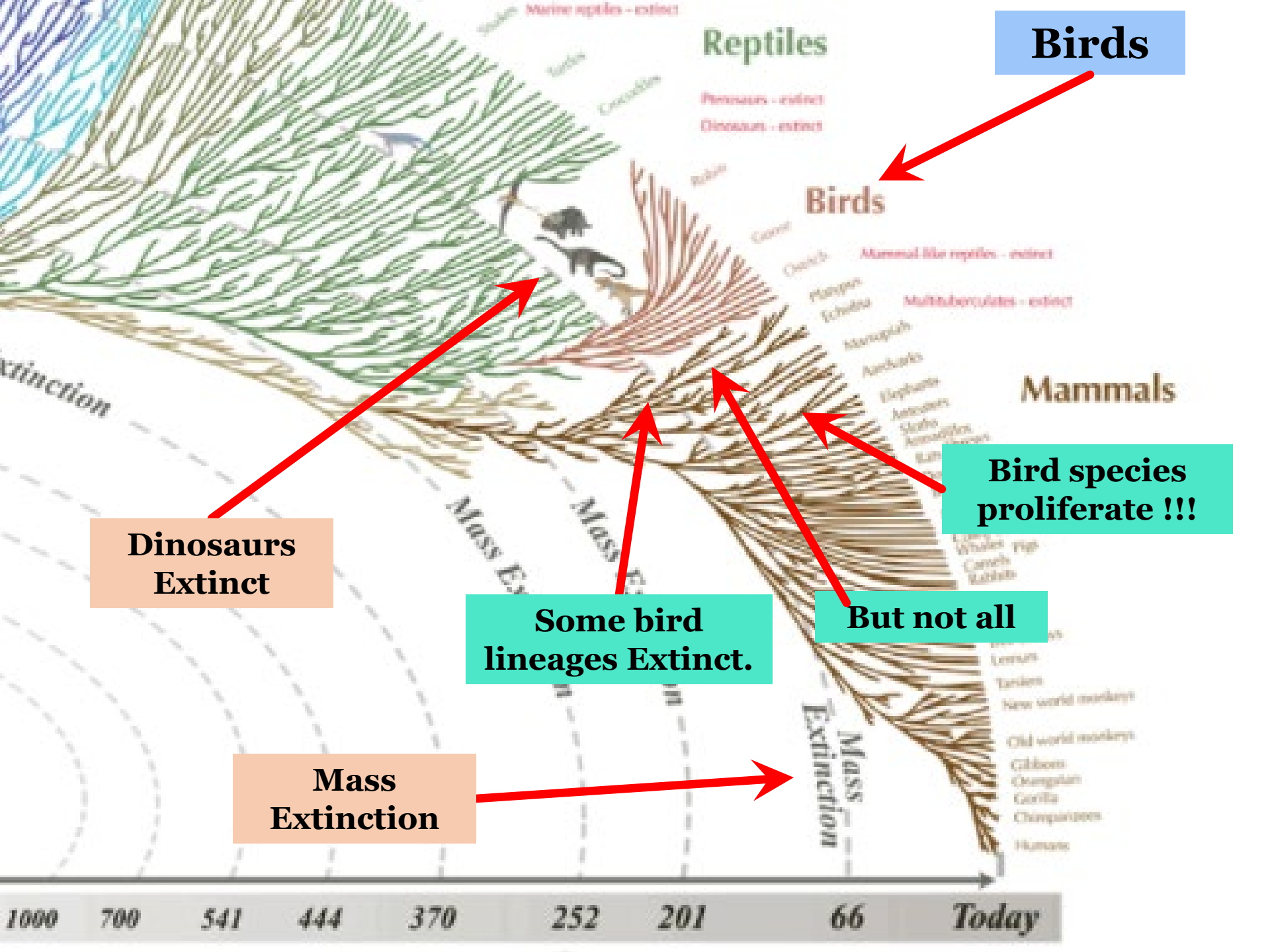
EVOLUTION OF BIRDS

WHAT MAKES A BIRD
A BIRD
AND NOT A DINOSAUR?



Graphic from The Origin and Diversification of Birds

Stephen L. Brusatte, Jingmai K. O'Connor, and Erich D. Jarvis (Current Biology Review, 2015)



Birds

Reptiles

Birds

Mammals

Bird species proliferate !!!

Dinosaurs Extinct

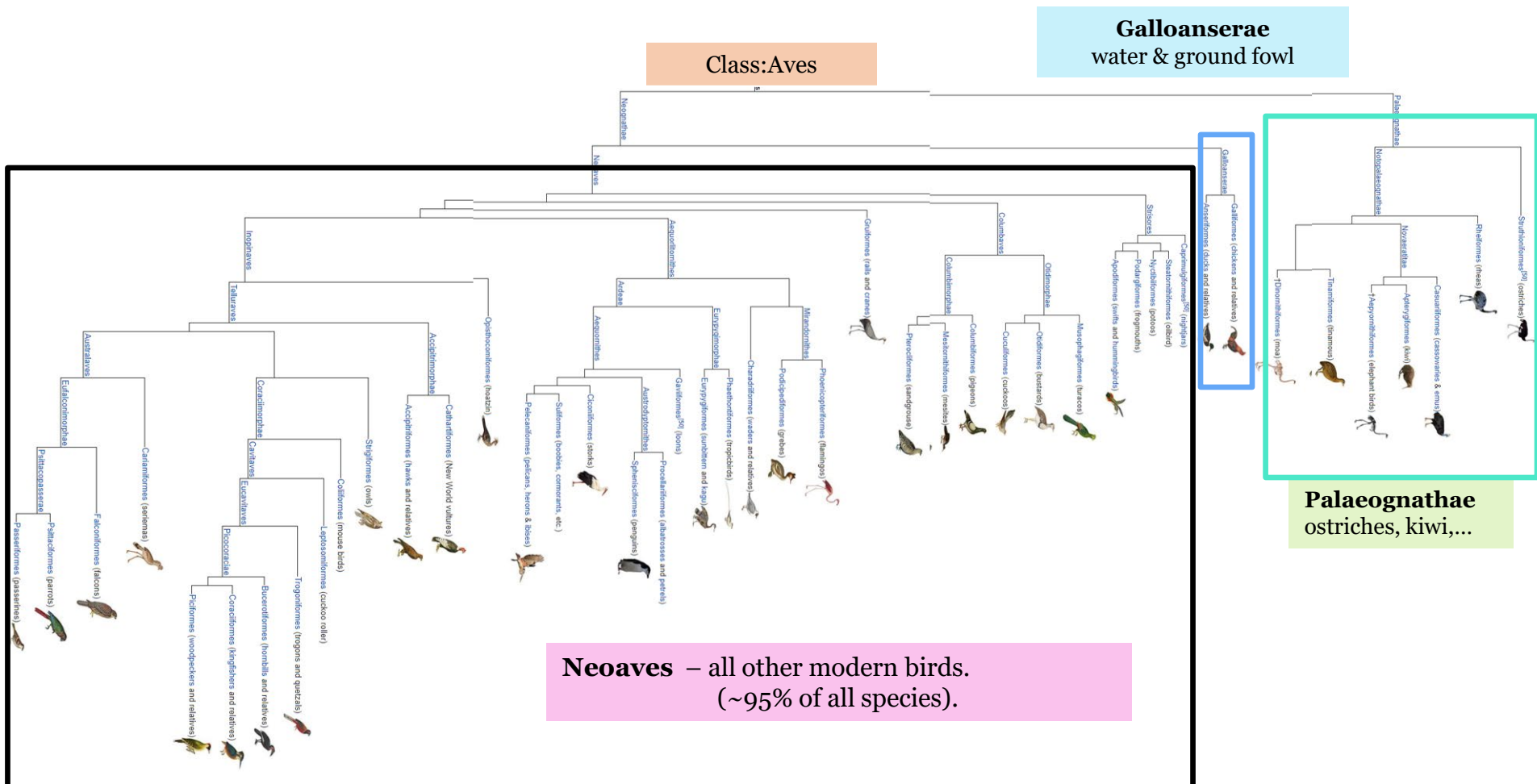
Some bird lineages Extinct.

But not all

Mass Extinction

1000 700 541 444 370 252 201 66 Today

3 GROUPS OF MODERN BIRDS

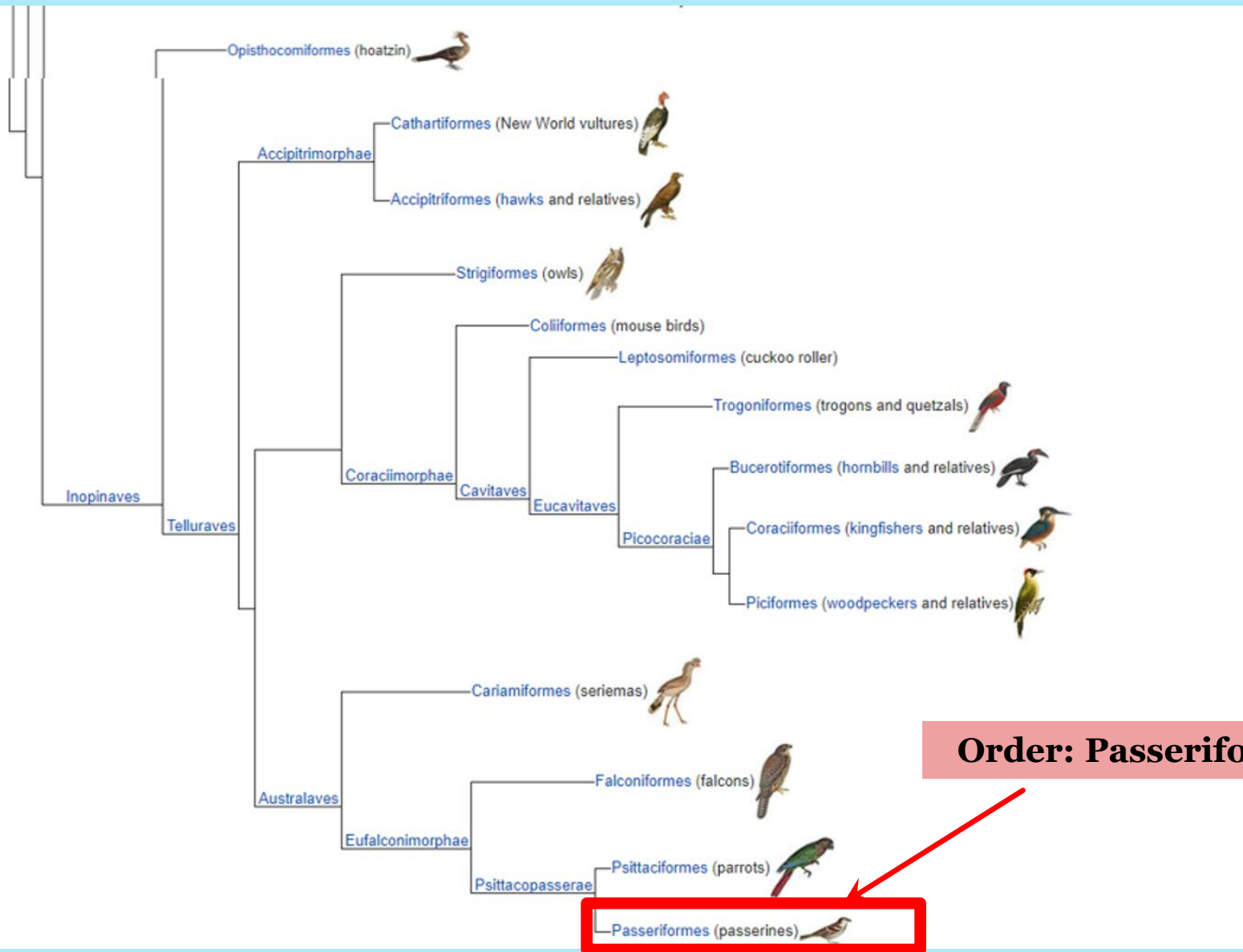


3 distinct lineages survived the Cretaceous–Paleogene extinction event 65 million years ago.

OUR STORY IS ABOUT
TITMICE
(PASSERINES)

PASSERIFORMES

CHANGE OVER TIME



ORDER: PASSERIFORMES

- ▶ Arrangement of toes
 - ▶ 3 forward, 1 back
 - ▶ Perching
- ▶ Syrinx (voice apparatus)
- ▶ 137 families
- ▶ More than 6,000 species
- ▶ >60% of the world's ~10,000 species
- ▶ Originated on Australian landmass
 - ▶ ~47 million years



SUBORDERS OF PASSERIFORMES

- ▶ Suborder – Acanthisitti (New Zealand wrens)

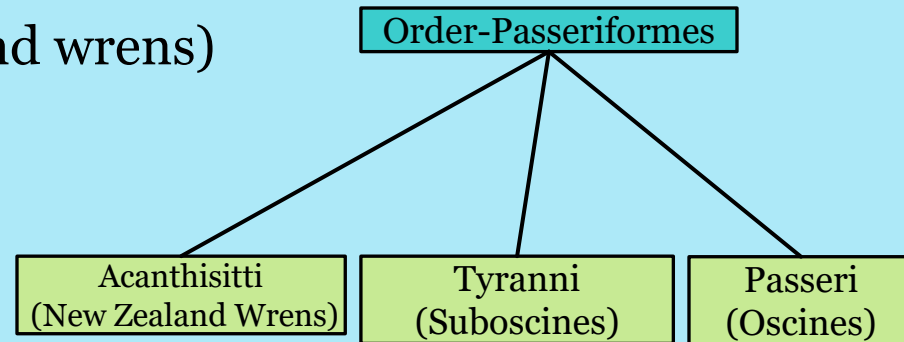
- ▶ 1 family
- ▶ 4 species

- ▶ Suborder – Tyranni (Suboscines)

- ▶ 16 families
- ▶ 1,356 species
- ▶ Old World suboscines
- ▶ New World flycatchers and allies
- ▶ Ovenbirds and allies

- ▶ Suborder – Passeri (Oscines (songbirds))

- ▶ 125 families
- ▶ 5158 species



THE TITMICE PHYLOGENY

3 PASSERINE SUBORDERS

Order-Passeriformes

Acanthisitti (New Zealand Wrens)

Tyranni (Suboscines)

Passeri (Oscines)

Order

Suborder

Infra-order

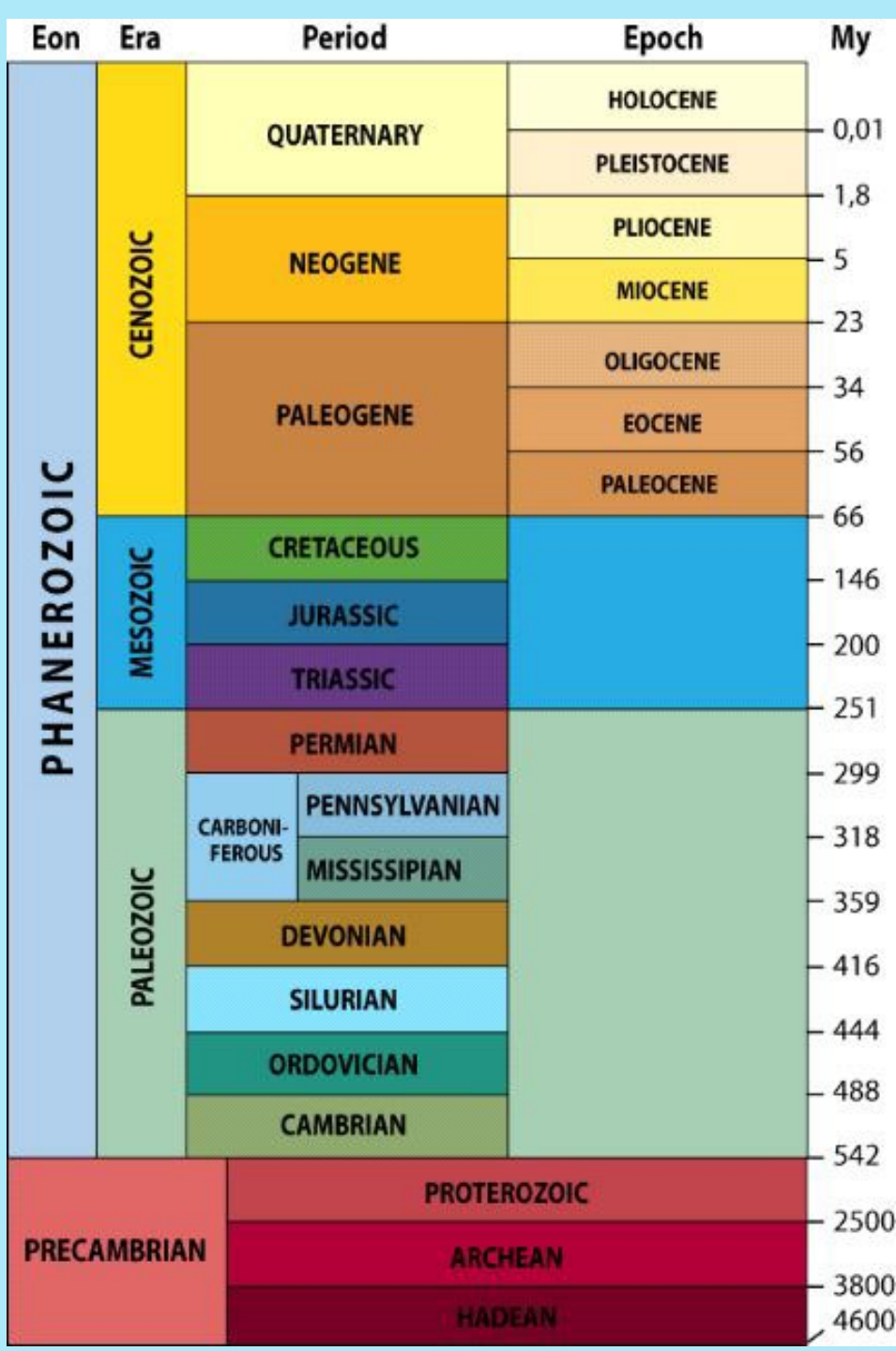
Parv-order

Super-family

Family

**EFFECT OF
GEOLOGIC EVENTS
ON SPECIATION**

GEOLOGIC TIME SCALE



Hominids appear

Extinction of dinosaurs & many bird lineages

Birds appear & diversify (Archaeopteryx 125-150 Ma)

Mammals appear

Reptiles appear

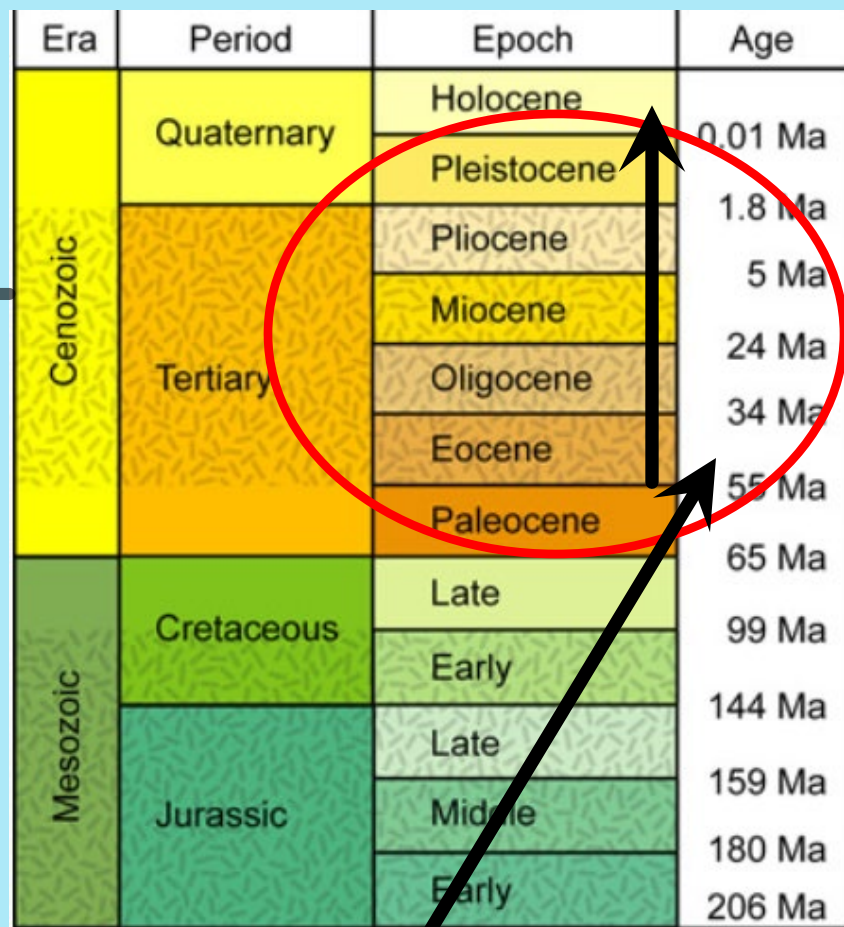
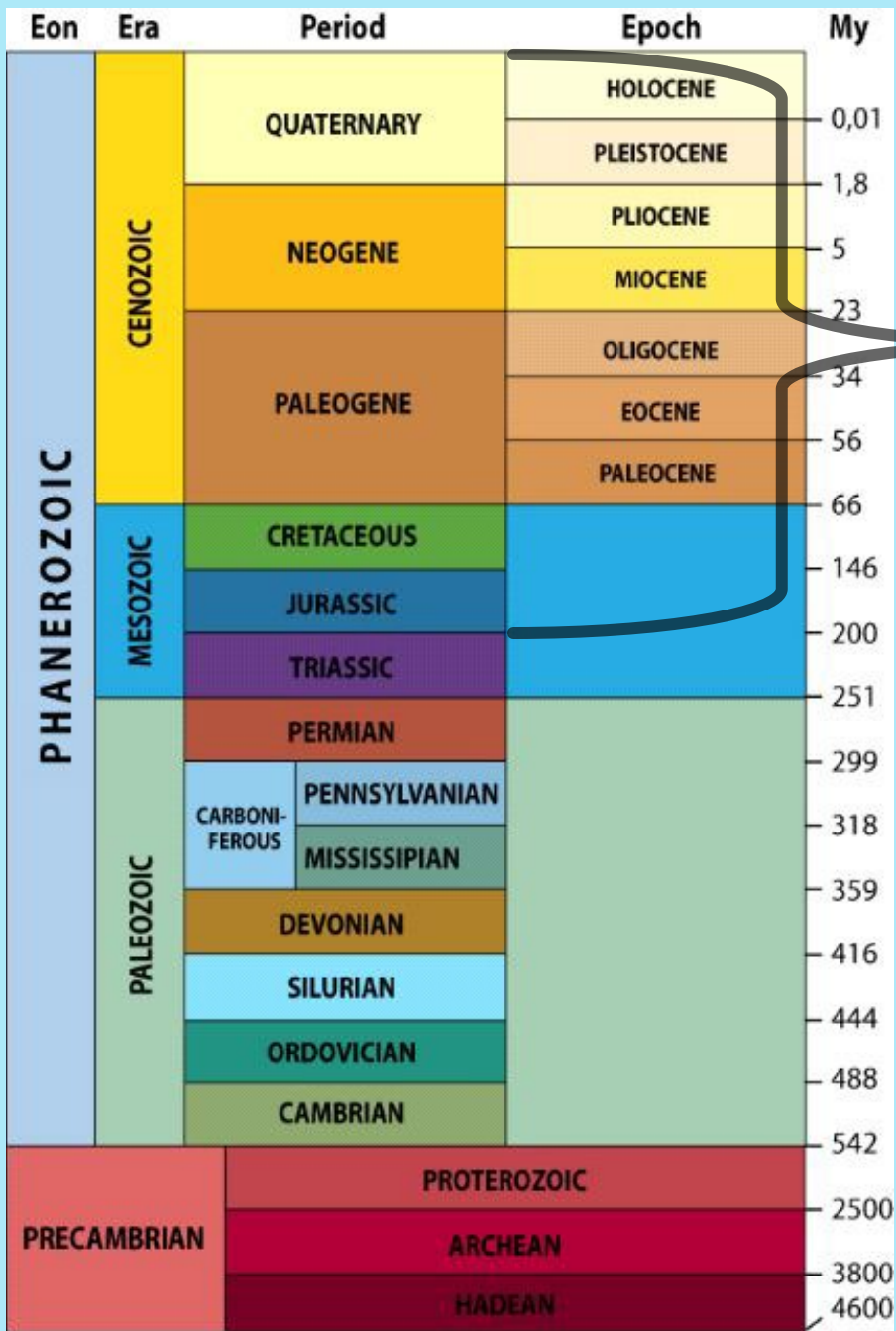
Insects appear

Fungi appear

Formation of earth

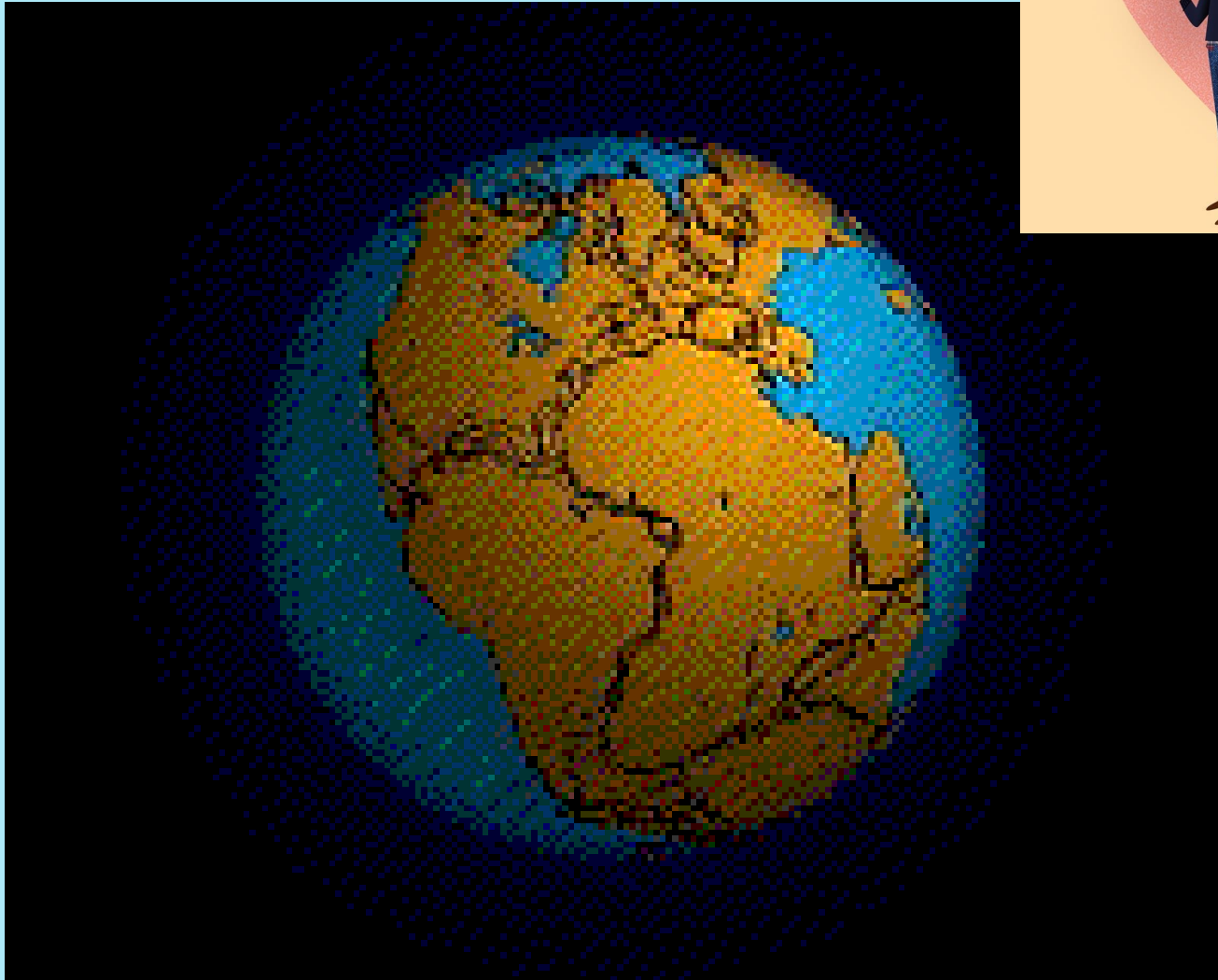


GEOLOGIC TIME SCALE

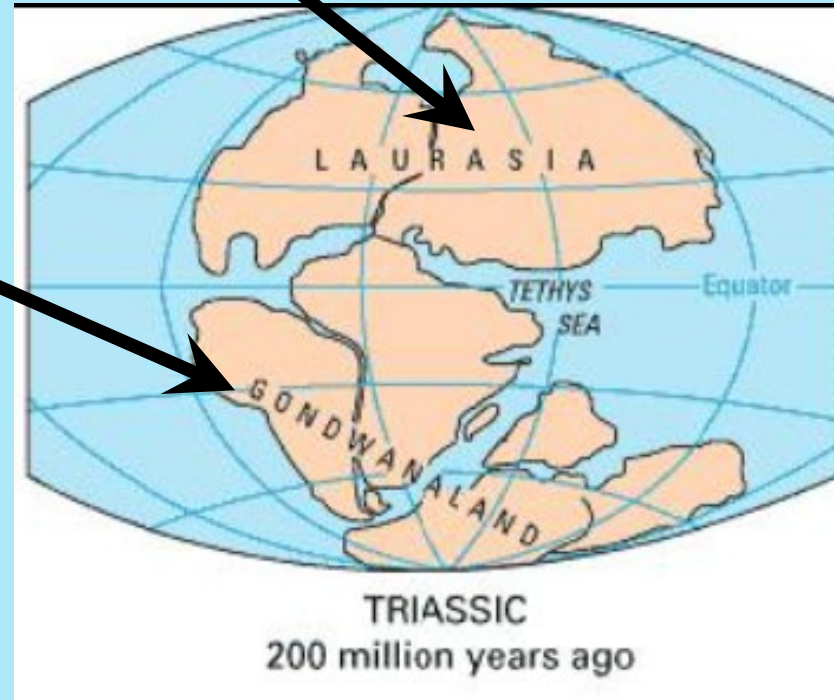


47 million years ago

THE BIG BREAK UP



PANGEA BREAKS UP INTO GONDWANALAND & LAURASIA



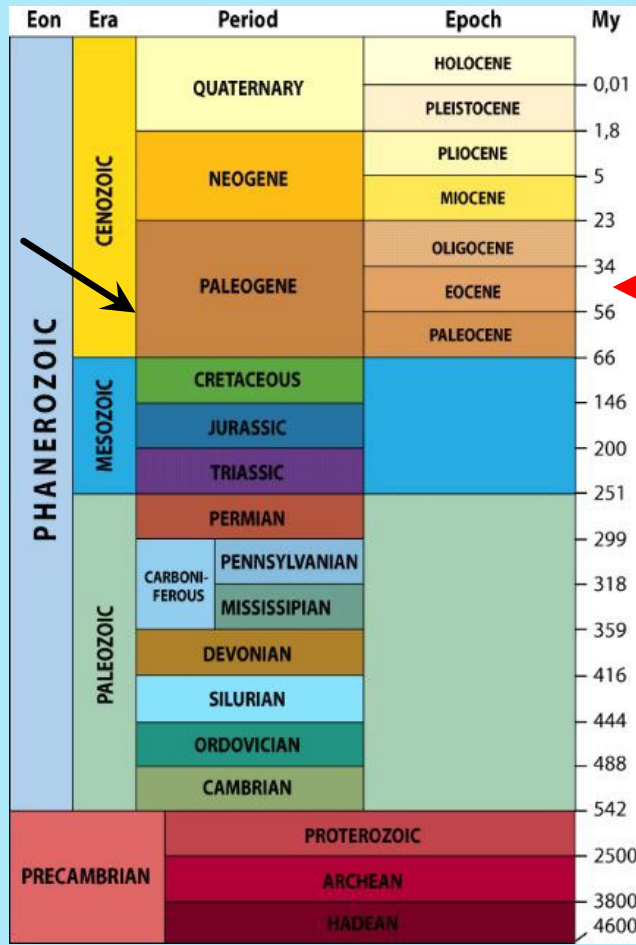
Eon	Era	Period	Epoch	My
PHANEROZOIC	CENOZOIC	QUATERNARY	HOLOCENE	0,01
			PLEISTOCENE	0,01
		NEOGENE	PLIOCENE	1,8
			MIOCENE	5
		PALEOGENE	OLIGOCENE	23
			EOCENE	34
	MIOZOIC	CRETACEOUS	PALEOCENE	56
			66	
			146	
	PALEOZOIC	CARBONIFEROUS	JURASSIC	200
			TRIASIC	251
		PENNSYLVANIAN	251	
			299	
		MISSISSIPPIAN	318	
			359	
		DEVONIAN	416	
		SILURIAN	444	
		ORDOVICIAN	488	
		CAMBRIAN	542	
PRECAMBRIAN	PROTEROZOIC	2500		
		ARCHEAN	3800	
		HADEAN	4600	



1 225 Million Years Ago



2 150 Million Years Ago



But too early to affect Passerine speciation

Huge affects on speciation

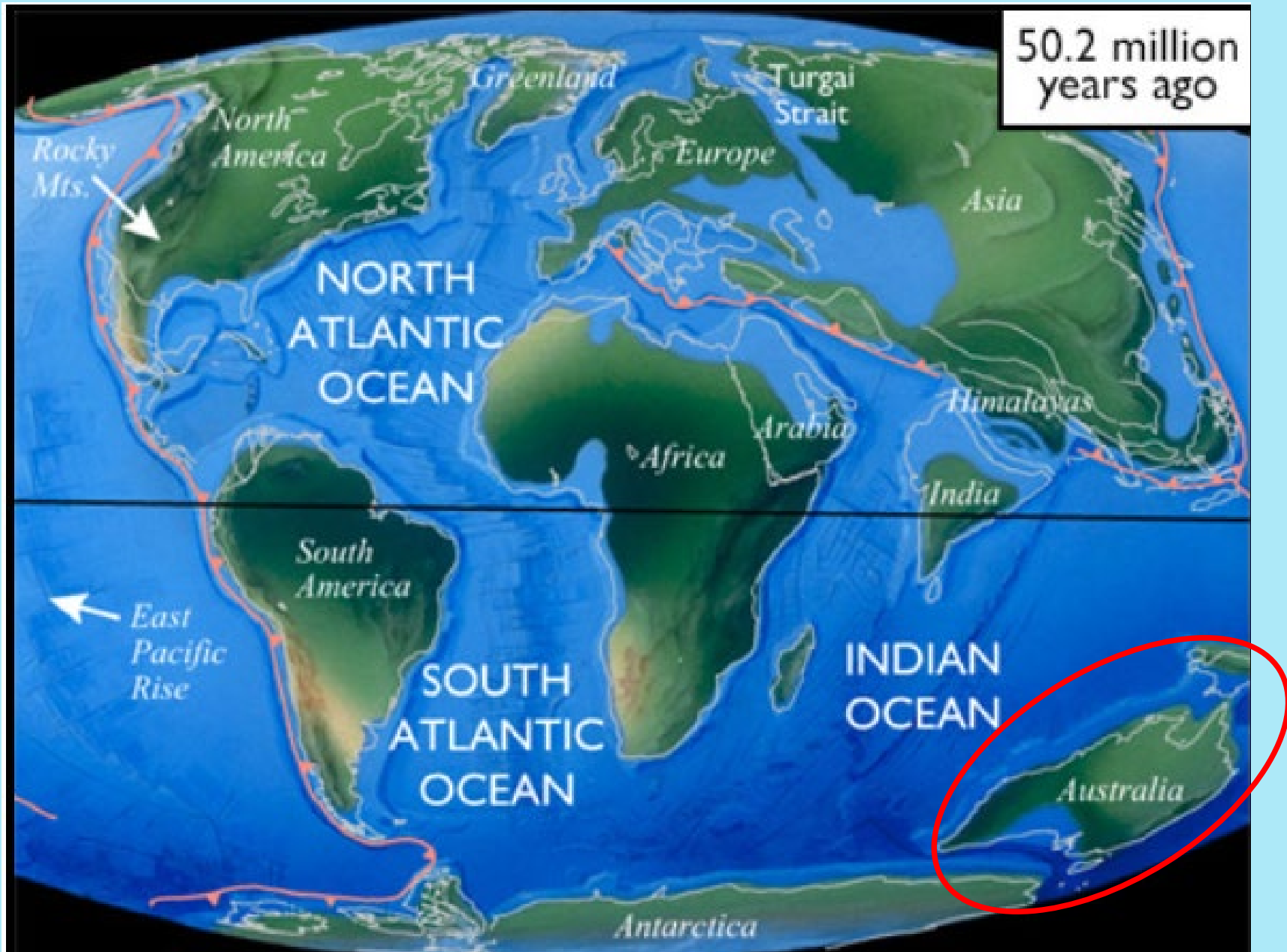
47

2

1

PASSERINES DIVERGE &
DIVERSIFY IN AUSTRALIA
~47 MILLION YEARS AGO

PASSERINES ~47 MILLION YEARS AGO



FACTORS IN
DIVERSIFICATION
OF PASSERINES

FACTORS IN THE DIVERSIFICATION OF PASSERINES



Geological Time Scale

ERA	PERIOD	EPOCH / AGE	Million Years Ago
CENOZOIC <i>Age of Mammals</i> 65.5 mya – present day	<i>Quaternary</i>	<i>Holocene</i>	<i>Today</i>
		<i>Pleistocene</i>	0.01
	<i>Tertiary</i>	<i>Pliocene</i>	1.6
		<i>Miocene</i>	5.3
		<i>Oligocene</i>	23.7
		<i>Eocene</i>	36.6
		<i>Paleocene</i>	57.8
			65.5
MESOZOIC <i>Age of Reptiles</i> 245 mya – 65.5 mya	<i>Cretaceous</i>	<i>Extinction of Dinosaurs</i>	144
	<i>Jurassic</i>		208
	<i>Triassic</i>	<i>First Dinosaurs</i>	245

Formation of Wallacea allows dispersal of passerines out of Australia (23 M)

Miocene expansion of temperate habitats & retreat of glaciers

Oligocene glaciation

Fragmentation of tropical habitats in cooler periods

Dispersal corridors linking landmasses

Mass extinctions open ecological niches

First birds appear

PASSERINE
SPECIATION
TIMELINE

PASSERINE SPECIATION TIMELINE



a) Last occurrence of hypothesized land bridge between north & south America

b) Formation of Cato Trough separating Australia and New Zealand

d) Closure of Turgai Strait (between Europe & Asia and into Arctic Sea)

e) Oligocene glaciation

Four different dispersals of Oscines out of Australia (20-30 Ma)

f) Uplift in Wallacea serves as a dispersal corridor for oscines from Australia to Asia

g) Late Oligocene warming

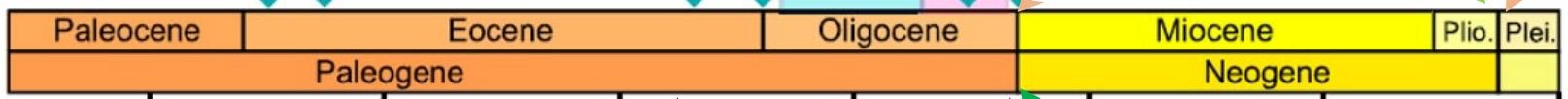
Common ancestor of Paridae and Remizidae diverges in tropical Africa and China

c) Ephemeral Antarctic ice sheets

Paridae colonize New World

Baeolophus originates in New World (most other Paridae, originate in Asia)

h) Maximum marine inundation of New Zealand



10 Orders Passeriformes & Psittaciformes diverge from Order Falconiformes (59 Ma)

9 Order-Passeriformes & Psittaciformes diverge (55 Ma)

8 Passerines began to diversify (47 Ma)

7 Sub-Orders Passeri & Tyranni diverge (44 Ma)

6 5 4 3 2

Oscines reach Europe (24 Ma), then Asia (23 Ma)

1 Families Paridae & Remizidae diverge (22 Ma)

2 Parv-Order Sylviida diverges from other families in Parv-order Sylviida and from Super-families Aegithaloidea, Sylvioidae, & Locustelloidea (26 Ma)

3 Family Paridae diverges from other members of Parv-Order Sylviida (27 Ma)

4 Parv-Order Sylviida diverges from Parv-Orders Muscicapida & Passerida (28 Ma)

5 Parv-Order Sylviida diverges from additional Families of Passerida (29 Ma)

6 Infra-Orders Passerides & Corvides diverge (31 Ma)

The Beringian land bridge and the warm temperatures of the Late Eocene provide route to North America from Asia (38 Ma)

Sylvioidae clades diversify & disperse across the Old World (25-30 Ma)

Climatic and ecological events of the Oligocen/Miocene boundary encourage oscine diversification (24 Ma)

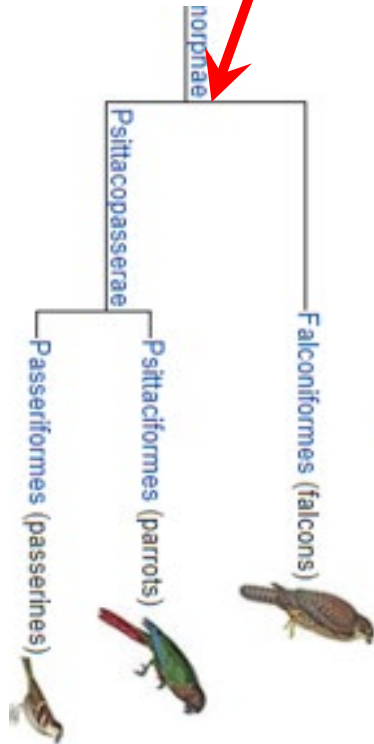
Oligocene glaciation affected passerine diversification through reduced temperature, permanent Antarctic ice sheet, global decline of broadleaf forests

Climatic & Geologic Events (likely affected divergence & dispersal)

- Divergence
- Dispersal

59 MILLION YEARS AGO

Era	Period	Epoch	Age	
Cenozoic	Quaternary	Holocene	0.01 Ma	
		Pleistocene	1.8 Ma	
	Tertiary	Pliocene	5 Ma	
		Miocene	24 Ma	
		Oligocene	34 Ma	
		Eocene	55 Ma	
		Paleocene	65 Ma	
		Cretaceous	Late	99 Ma
			Early	144 Ma
			Jurassic	Late
Middle	180 Ma			
Early	206 Ma			
Triassic		253 Ma		

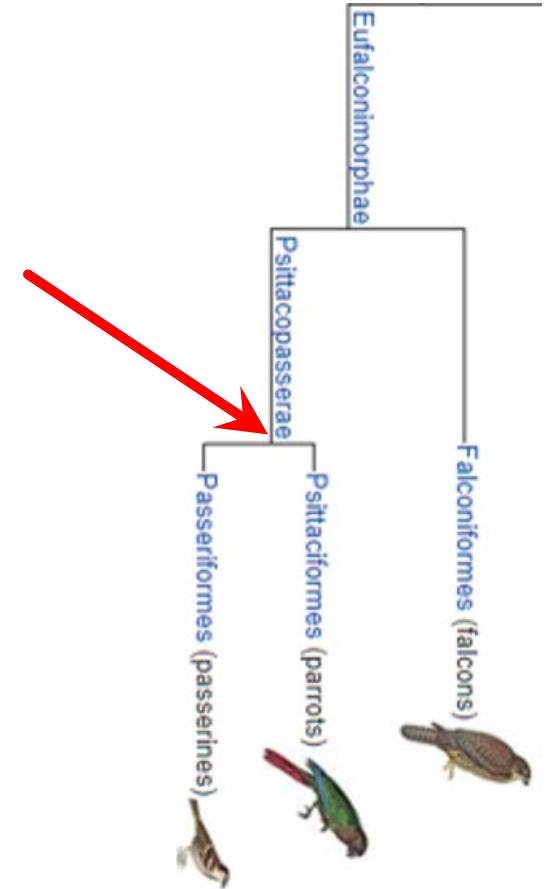


10 Taxon
Psittacopasserae
diverges from Order
Falconiformes

55 MILLION YEARS AGO

9 Orders
Passeriformes &
Psittaciformes
diverge

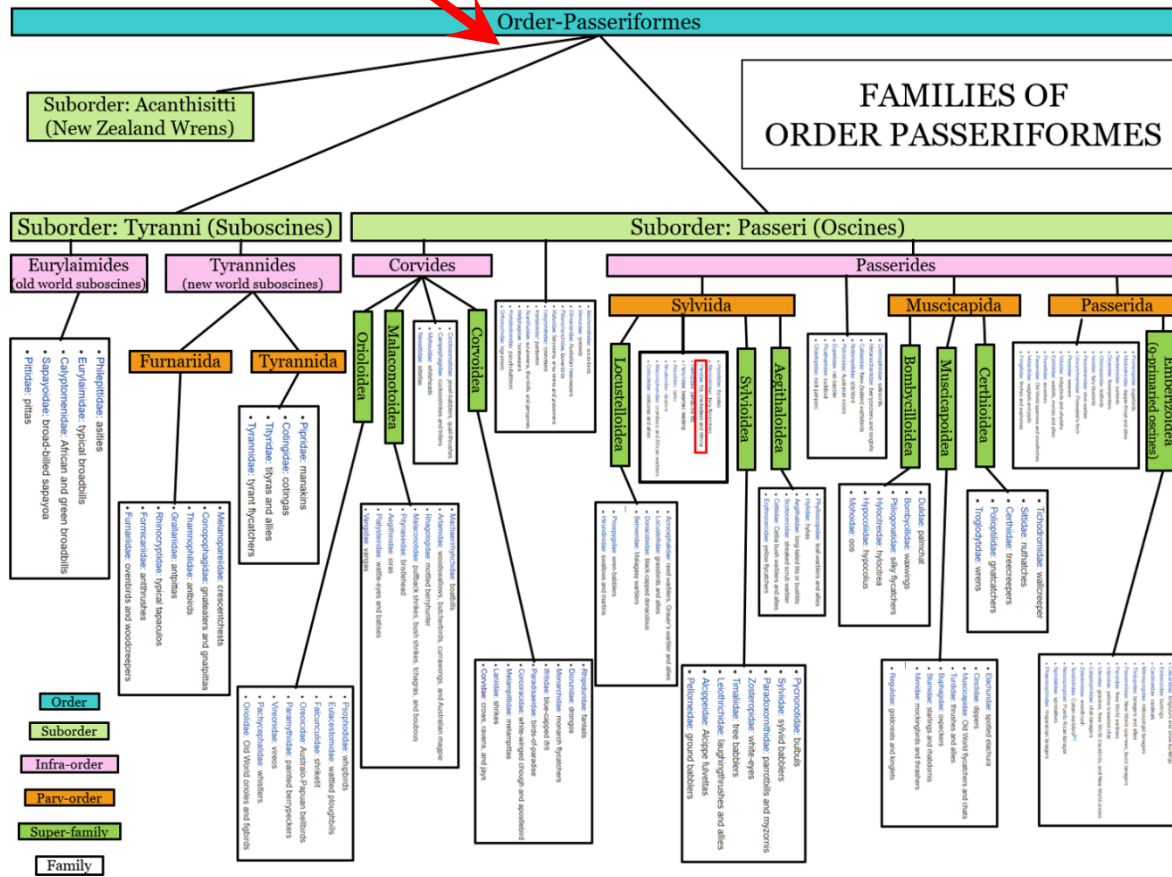
Era	Period	Epoch	Age
Cenozoic	Quaternary	Holocene	0.01 Ma
		Pleistocene	1.8 Ma
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		Miocene	24 Ma
		Oligocene	34 Ma
		Eocene	55 Ma
		Paleocene	65 Ma
		Cretaceous	Late
Mesozoic	Cretaceous	Early	144 Ma
		Late	159 Ma
	Jurassic	Middle	180 Ma
		Early	206 Ma
Triassic		253 Ma	



47 MILLION YEARS AGO

Era	Period	Epoch	Age
Cenozoic	Quaternary	Holocene	0.01 Ma
		Pleistocene	1.8 Ma
	Tertiary	Pliocene	5 Ma
		Miocene	24 Ma
		Oligocene	34 Ma
		Eocene	55 Ma
		Paleocene	65 Ma
Mesozoic	Cretaceous	Late	99 Ma
		Early	144 Ma
	Jurassic	Late	159 Ma
		Middle	180 Ma
		Early	206 Ma
Triassic		253 Ma	

8 Order-Passeriformes begins to diversify as Sub-Orders Passeri & Tyranni diverge from Sub-Order Acanthisitti



- Order
- Suborder
- Infra-order
- Parv-order
- Super-family
- Family

28 MILLION YEARS AGO

Era	Period	Epoch	Age
Cenozoic	Quaternary	Holocene	0.01 Ma
		Pleistocene	1.8 Ma
	Tertiary	Pliocene	5 Ma
		Miocene	24 Ma
		Oligocene	34 Ma
		Eocene	55 Ma
		Paleocene	65 Ma
Mesozoic	Cretaceous	Late	99 Ma
		Early	144 Ma
	Jurassic	Late	159 Ma
Middle		180 Ma	
Triassic	Early	206 Ma	
			253 Ma



4 Parv-Order Sylviida
diverges from other families
Super-families

