

# Eocene insight into the origin of extant avian biodiversity

**Julia Clarke**

**Department of Geological Sciences**

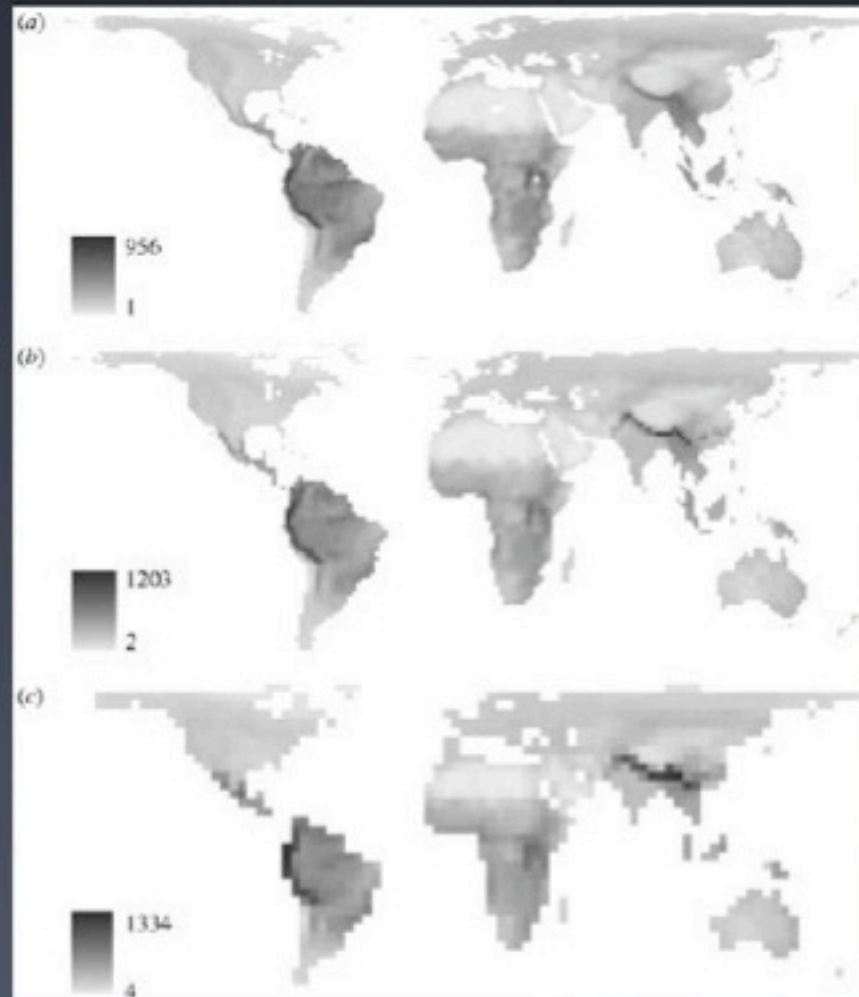
Jackson School of Geosciences

University of Texas at Austin



Disjunctive  
distribution of  
extant  
species

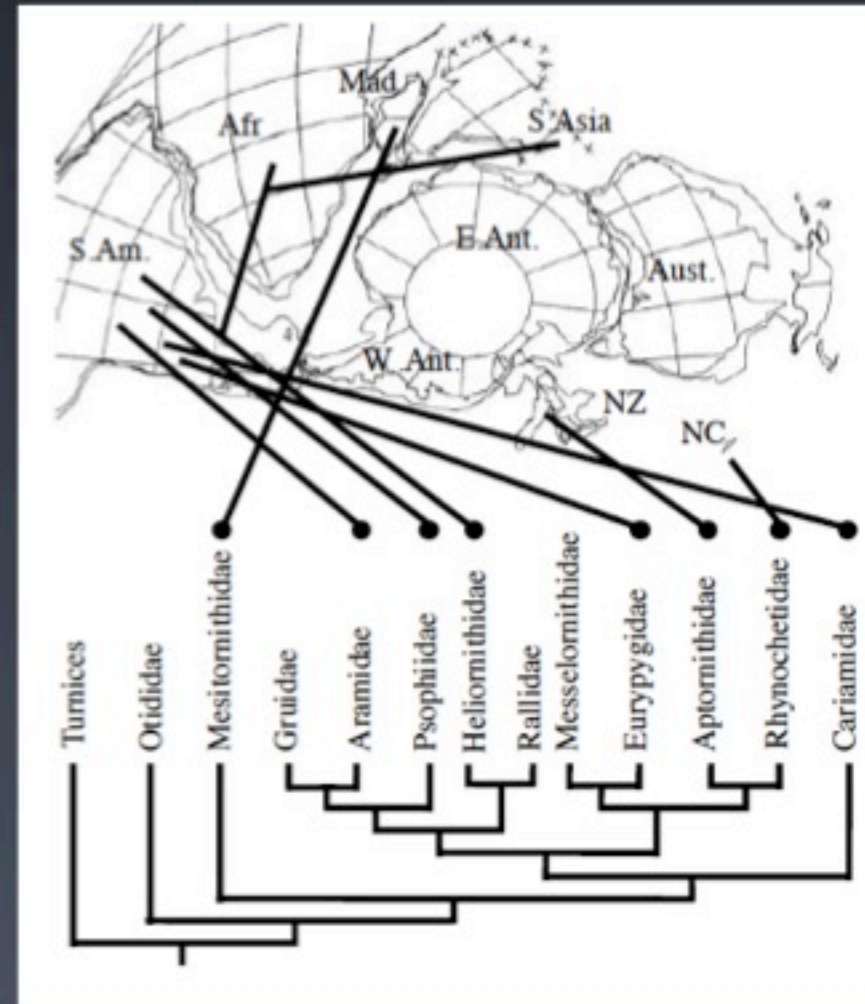
Tropical-  
subtropical  
regions  
contain most  
diversity



*Davies et al., 2007*

Long held hypothesis  
that living bird distribution  
driven by early vicariance

Extant avian diversity  
reflects ancient  
Gondwanan distributions

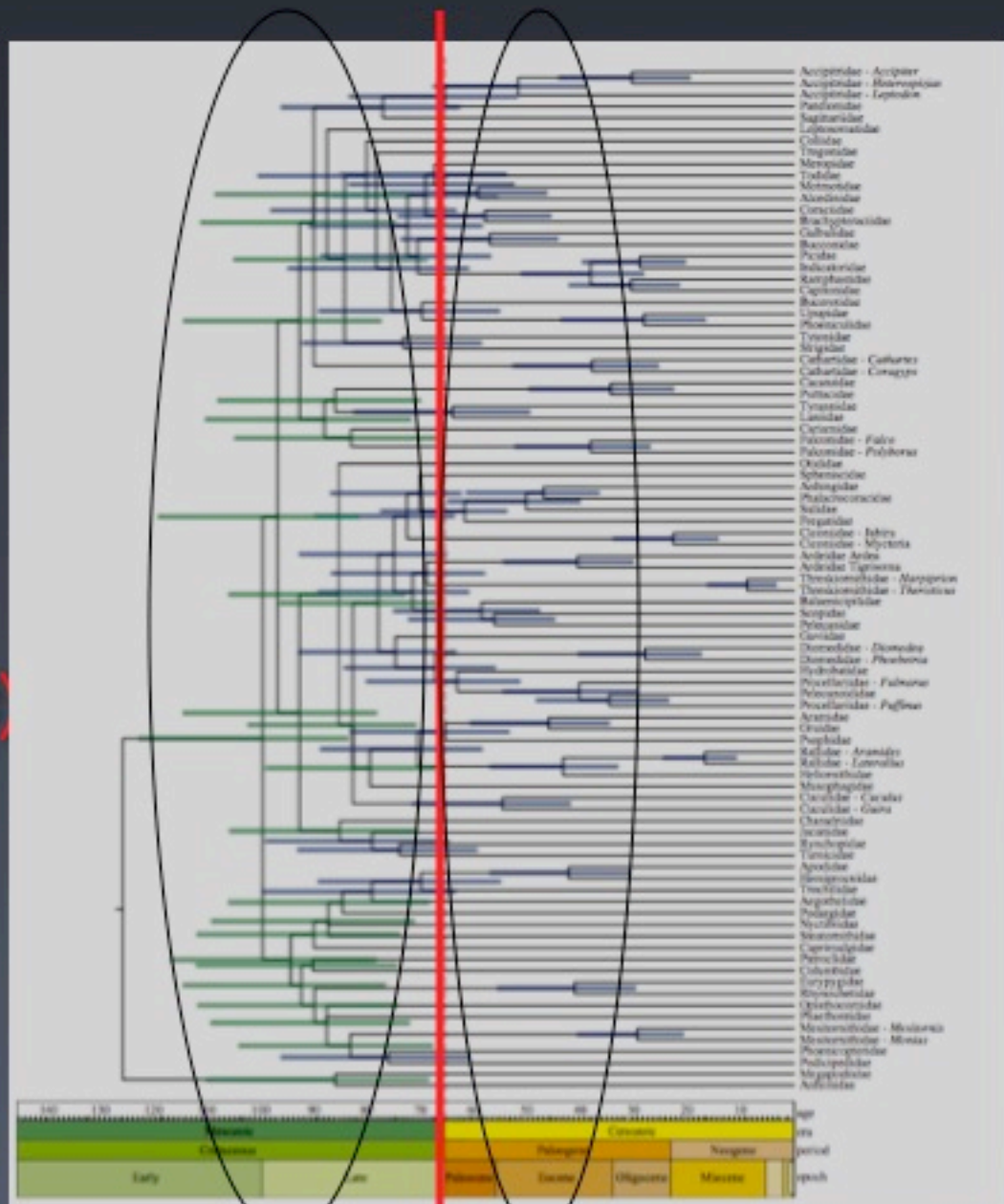


Cracraft, 2001



Molecular  
divergence estimates  
yield Mesozoic origins  
for most major lineages

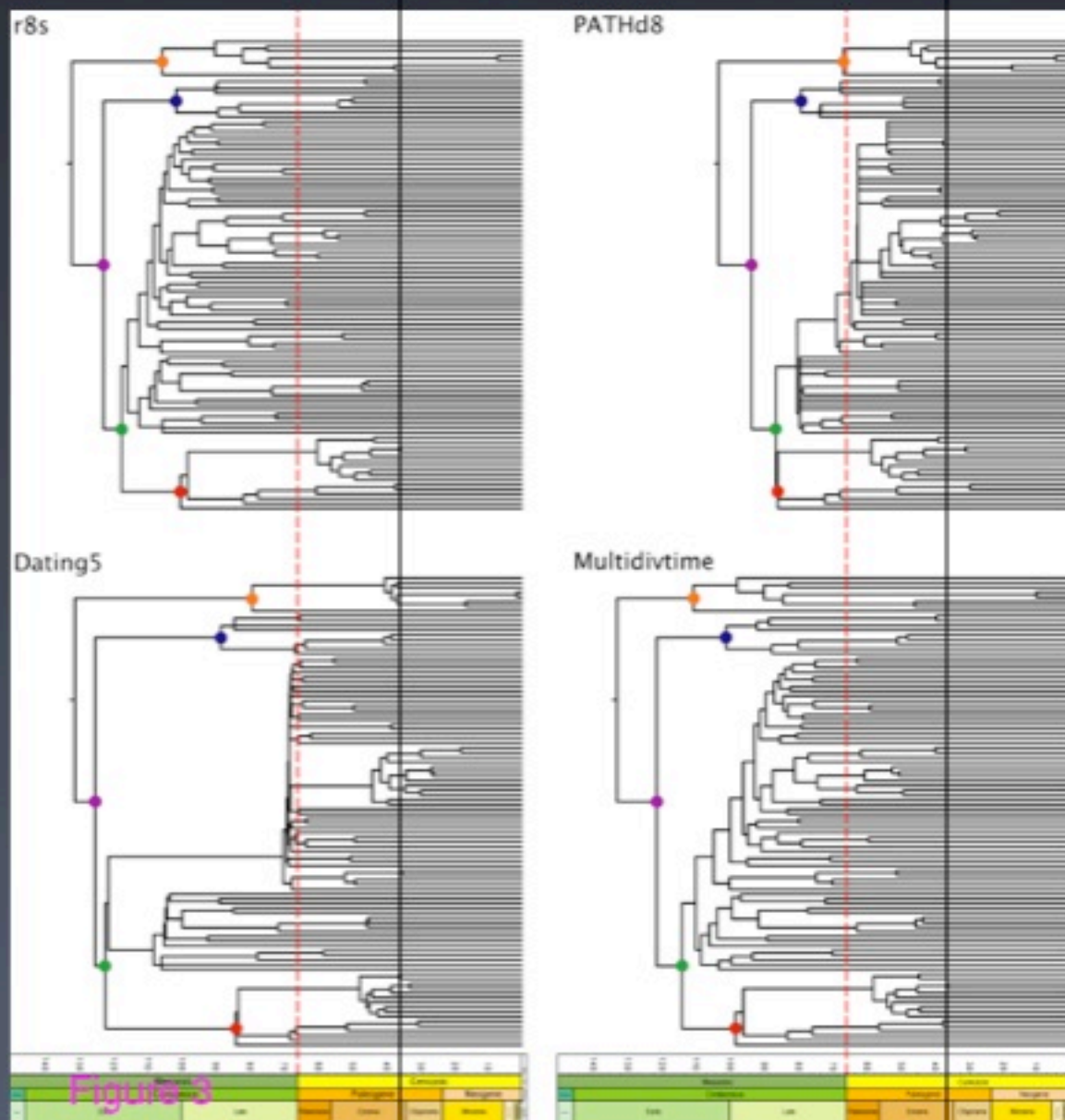
Early Tertiary origins  
for extant parts (*crowns*)  
of these lineages



Brown et al, 2007

K/Pg

## By late Eocene: extant diversity established



# The Eocene Record

Phylogenetic analyses including extinct and extant species are our only test of these hypotheses.

Are biogeographical patterns and extant avian ecologies of ancient or recent origin?

*At issue: potential drivers of avian diversity and distribution*



New data: Fossil  
Butte Member of  
the Green River  
Formation of  
Wyoming ( $51.66 \pm 0.17\text{Ma}$ )



Aves, Coliiformes

Florissant Formation of Colorado  
34.07+/-0.10Ma

'New' old  
data:

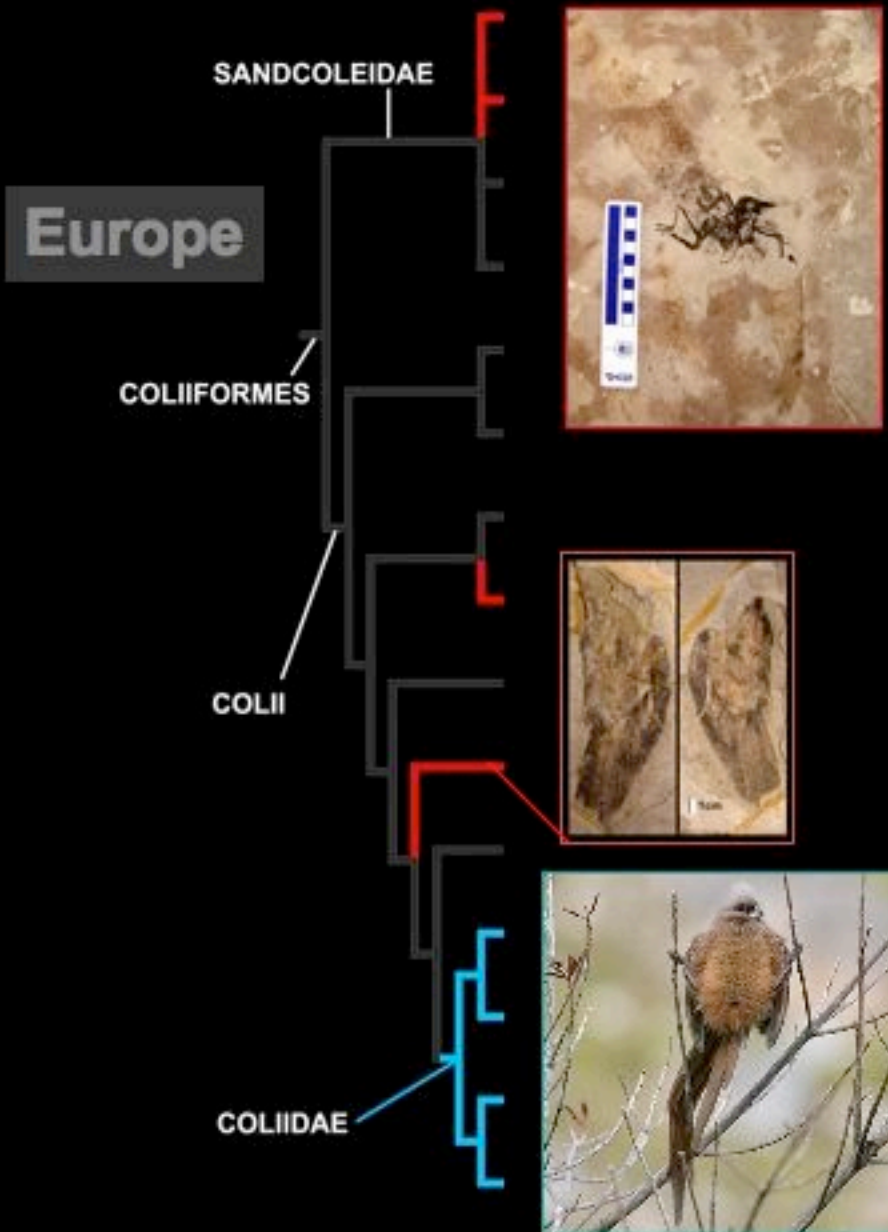


(*Palaeospiza  
bella*, MCZ  
2222)

Described by  
Allen, (1878)

Early parts  
of the  
lineage  
diverse in  
Europe and  
North  
America

## North America

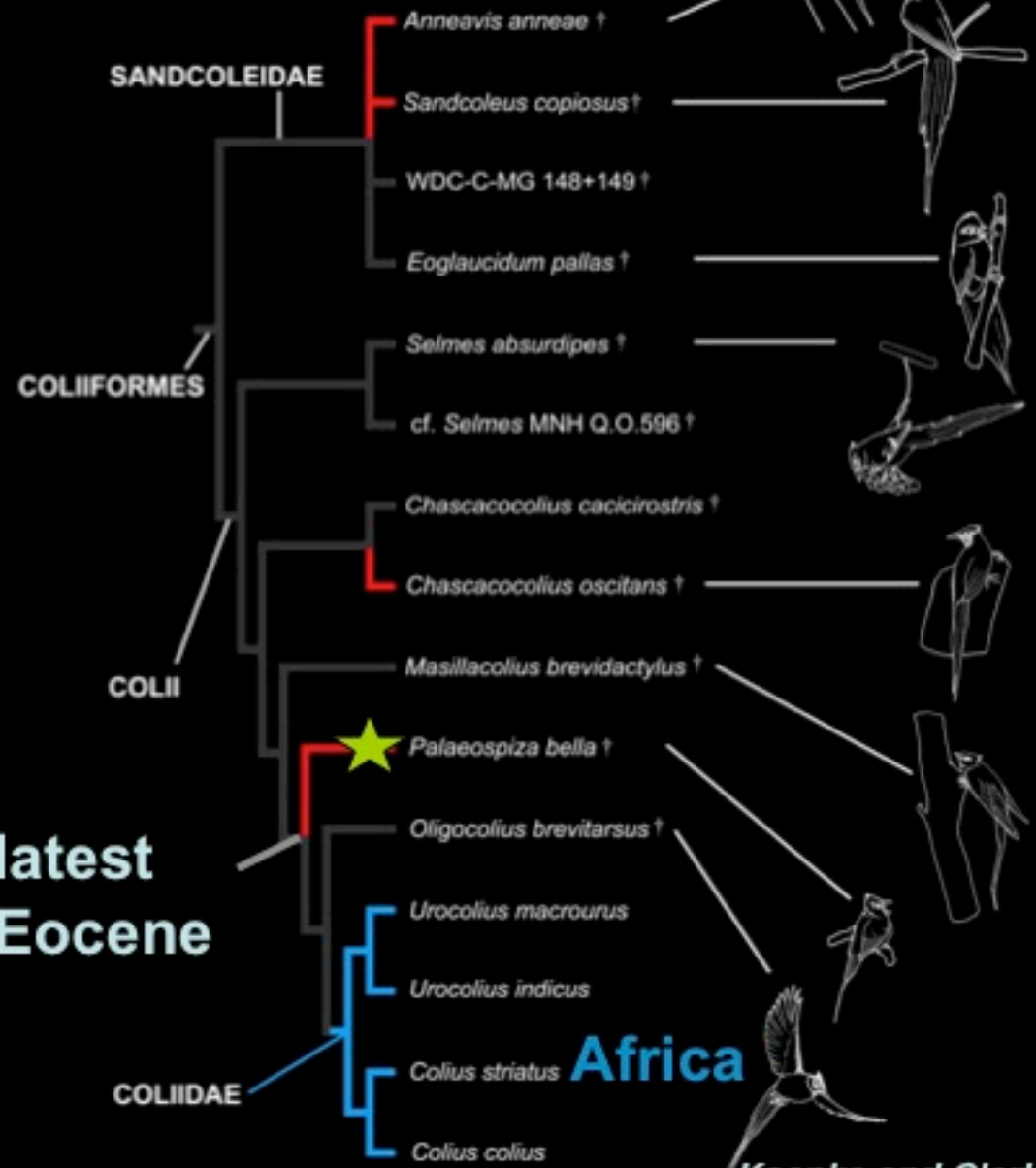


Coliidae:  
mousebirds  
6 species  
sub-Saharan  
Africa

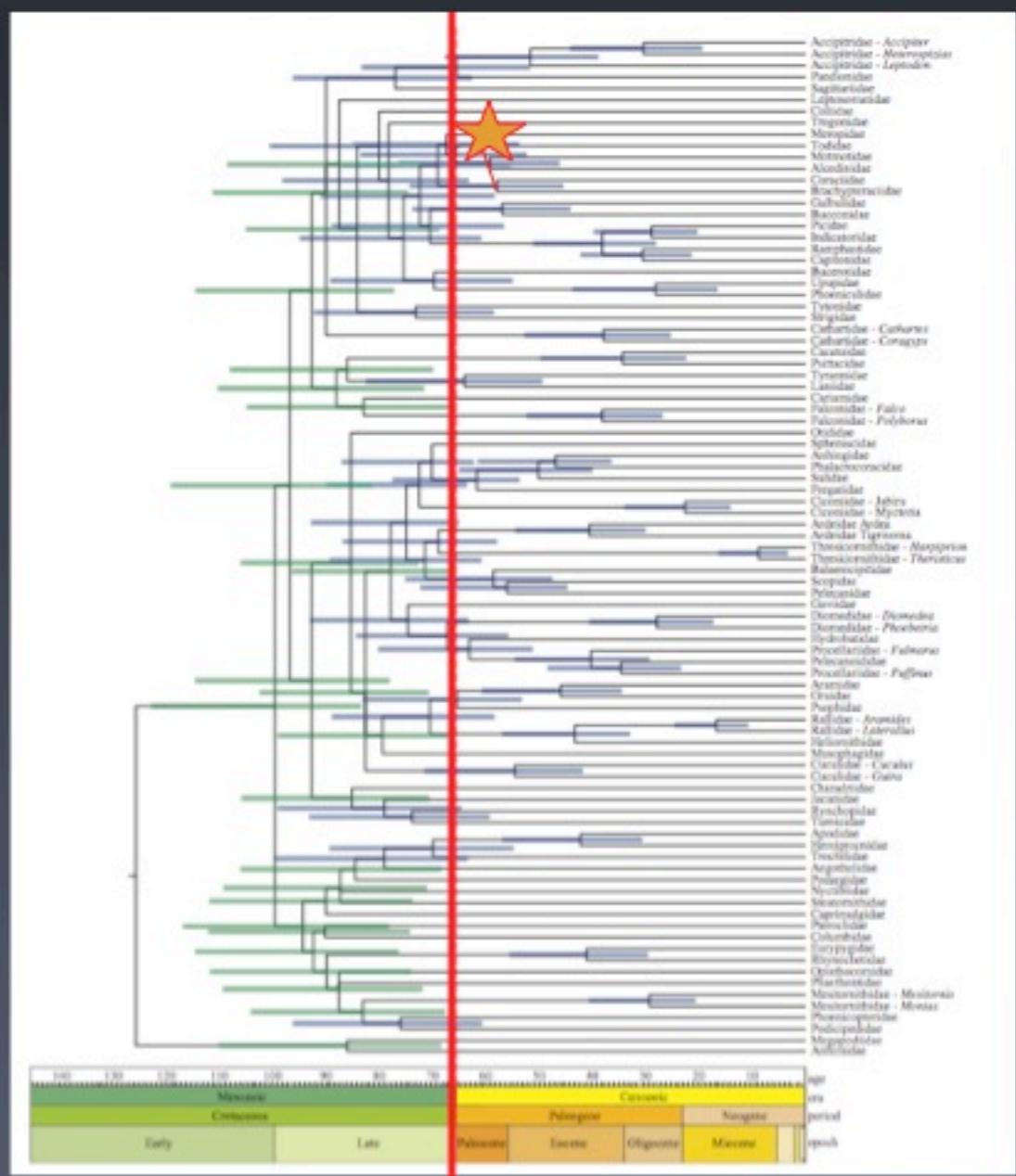
Persistence of mousebirds in NA at least until the E/O boundary



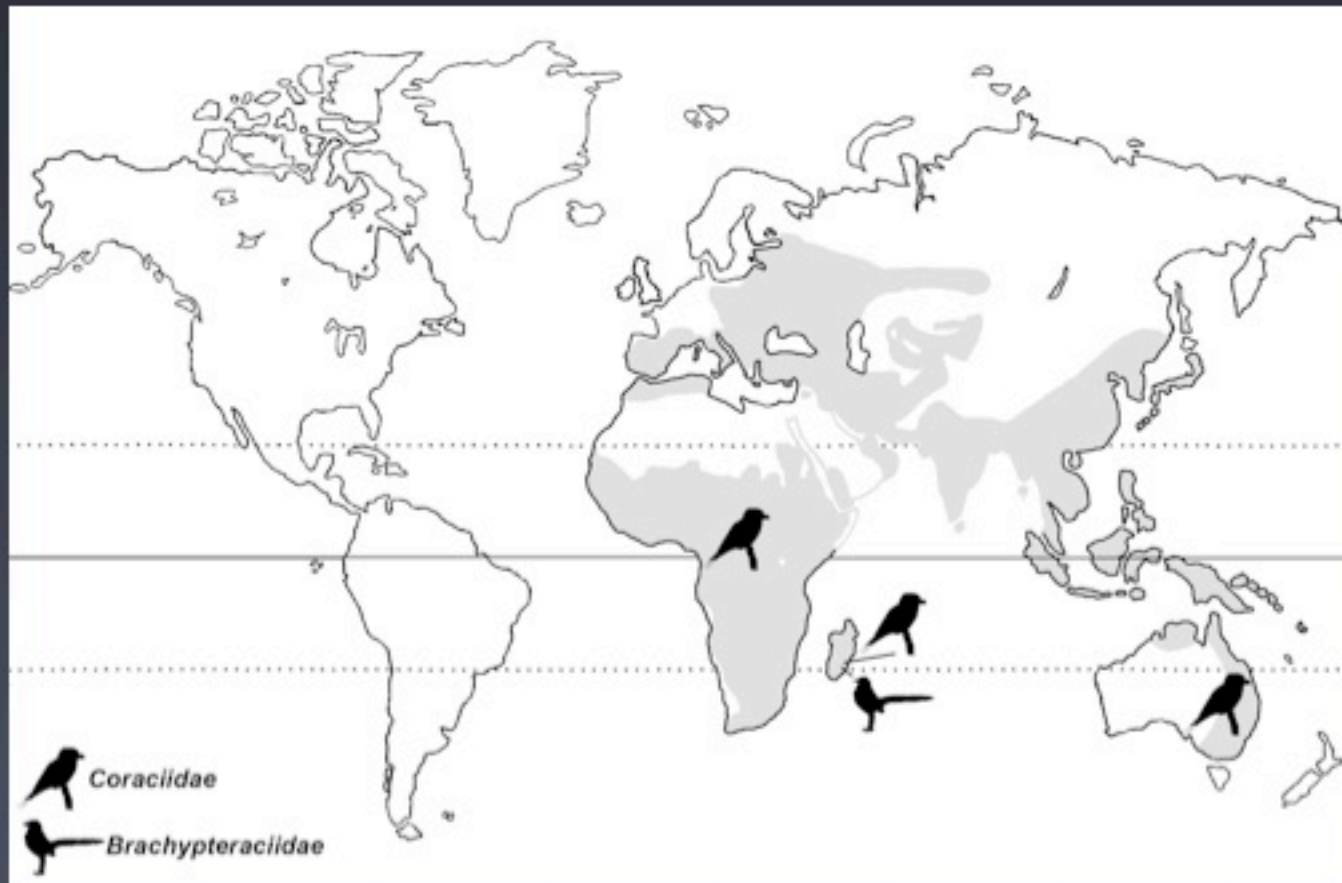
latest Eocene



Origin of two lineages  
of Coracii placed in  
Paleogene by  
divergence time  
estimates

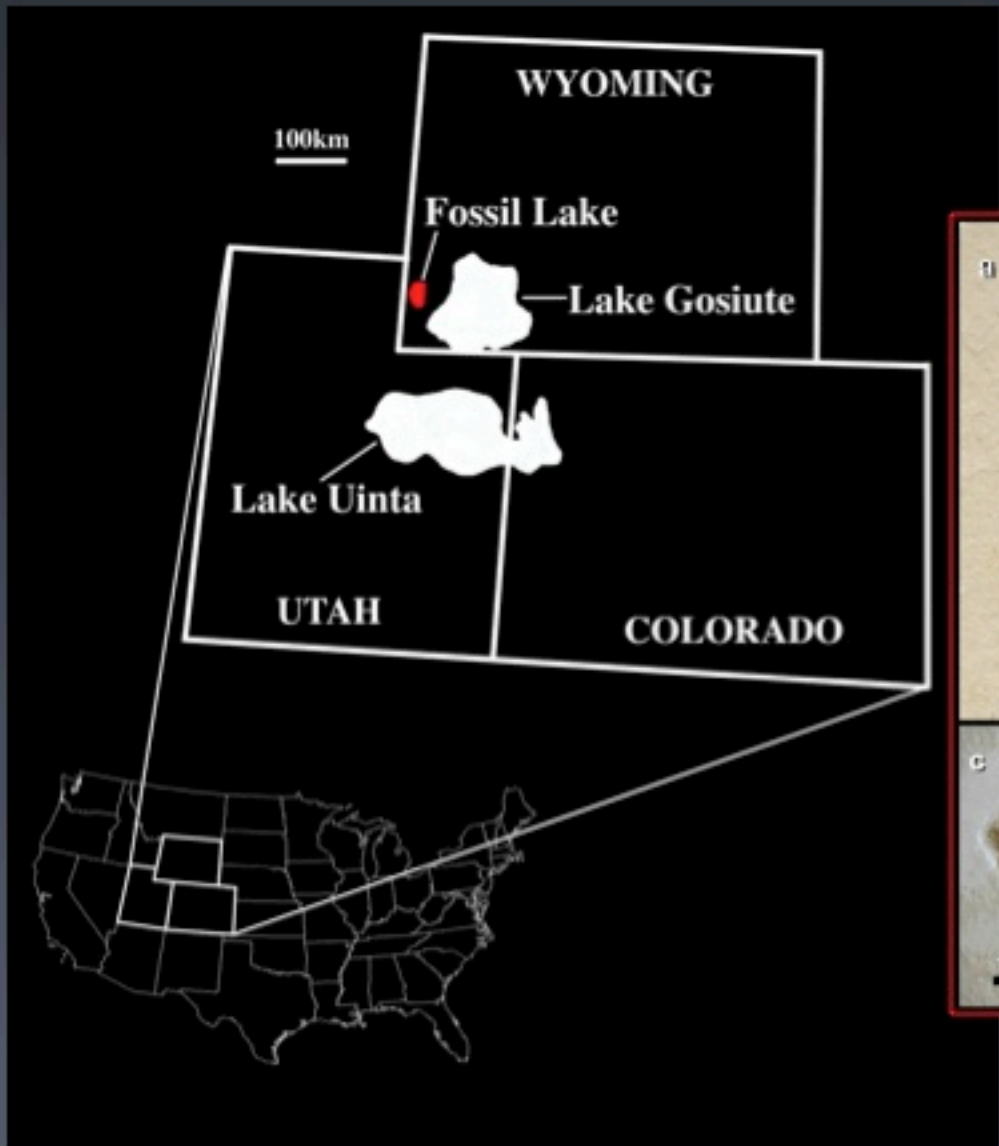


K/Pg



**Extant distribution: Madagascar, Africa, Europe, Australasia**

Abundant in the  
early Eocene of  
North America



Fossil Butte Member  
(Green River Formation)  $51.66 \pm 0.17$ Ma

Modified from Grande, 1994

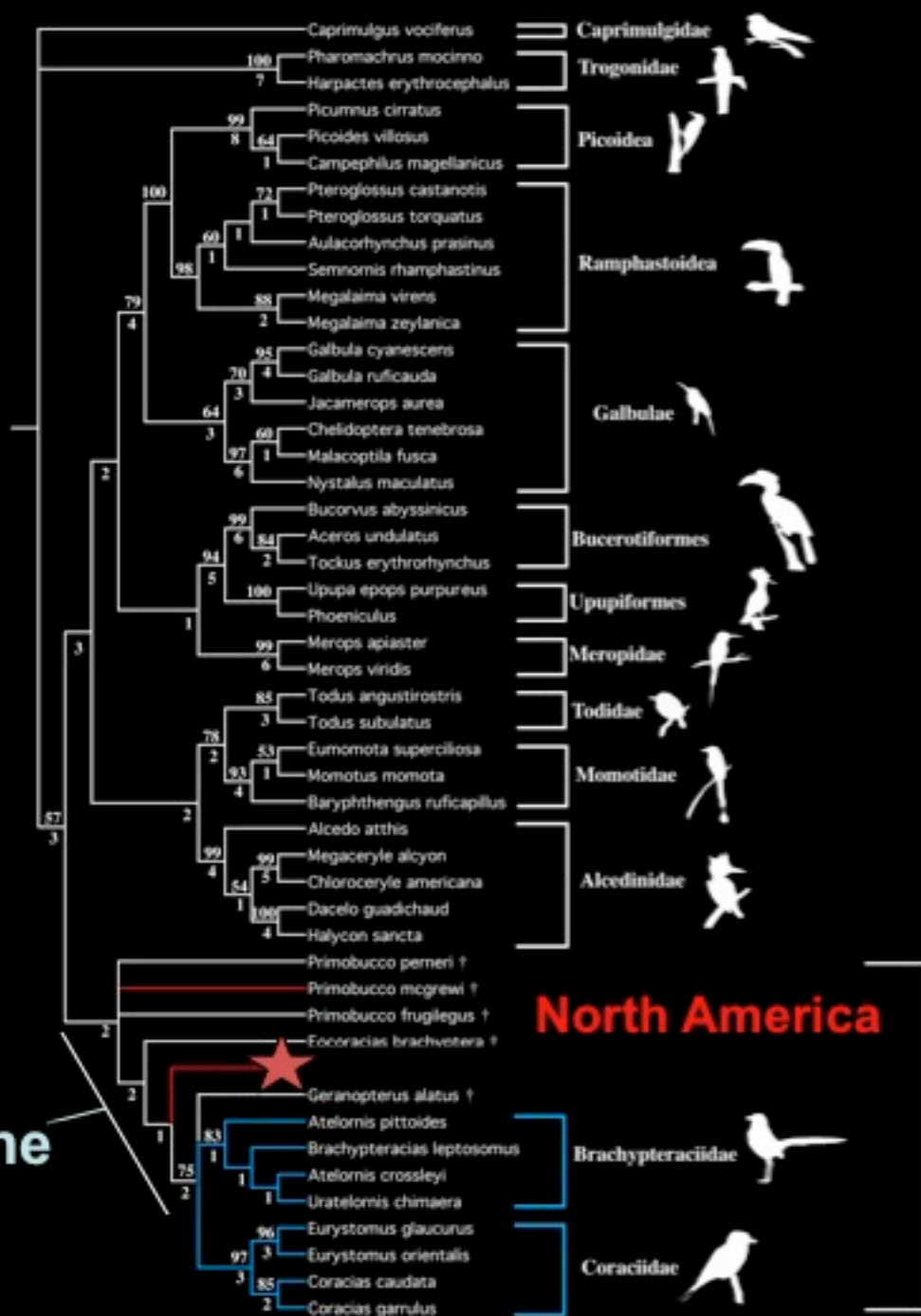
*Ksepka and Clarke, in press*

*New Eocene  
species*

*Green River  
Formation.*







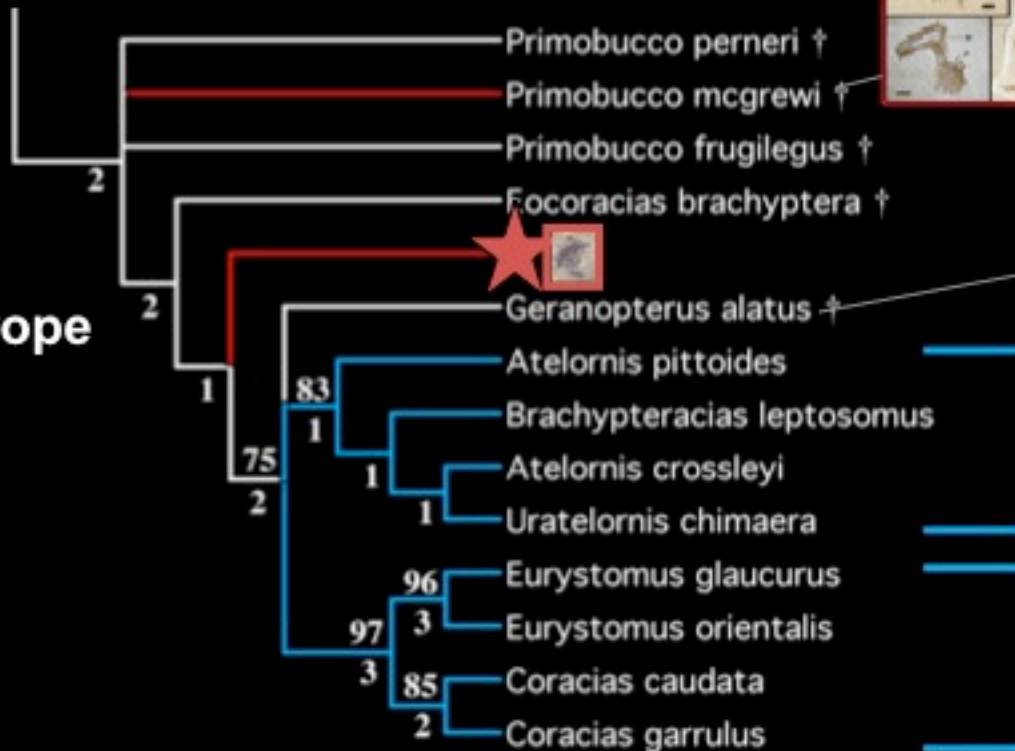
Combined MP analysis:  
139 morph. & 4411 bp  
(RAG-1 and *c-myc*, NADH  
dehydrogenase subunit 2).

# North America



35 Ma

Europe



Brachypteraciidae  
Madagascar



Coraciidae

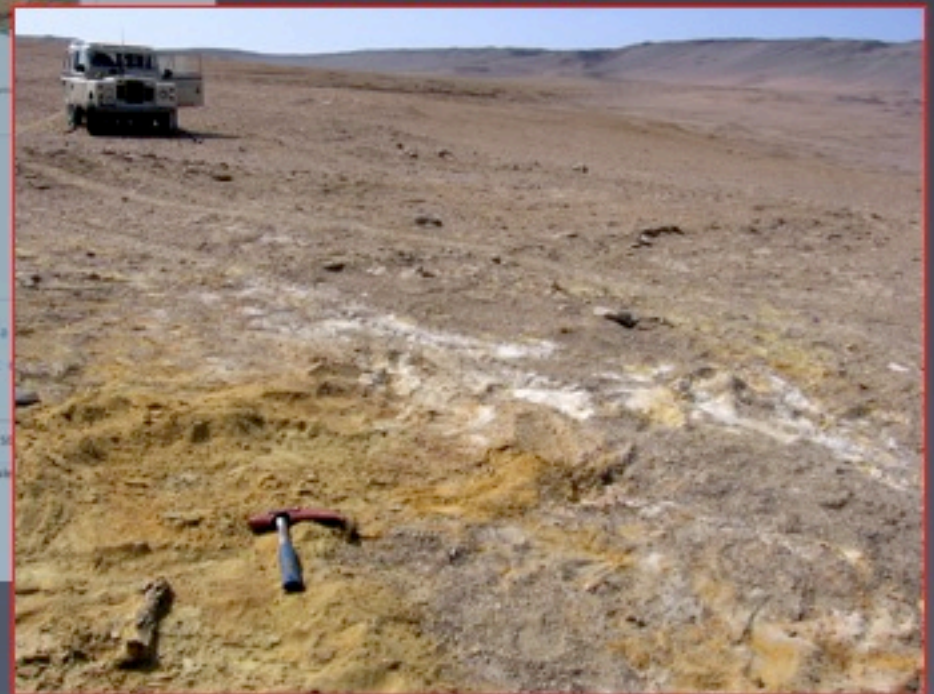
Africa, Europe, Australasia







**Pisco Basin, Peru**



Two new species from  
Peru (Paleolat. 18° S)

*Icadyptes* 36 Ma



*Perudyptes* 42 Ma



Clarke et al., 2007 PNAS

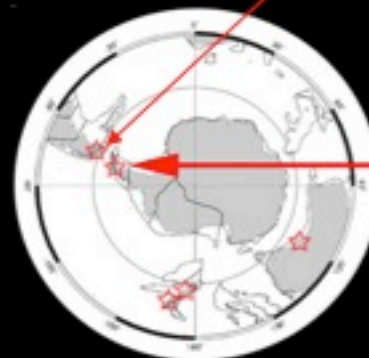
# Eocene

All previous  
Paleocene and  
Eocene penguins  
were from high  
latitudes

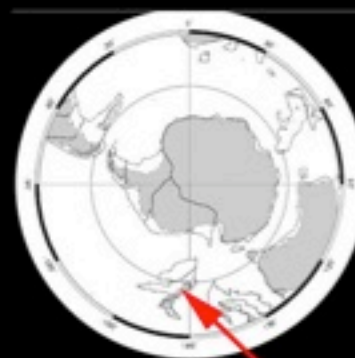


CADIC  
Clarke et al., 2003

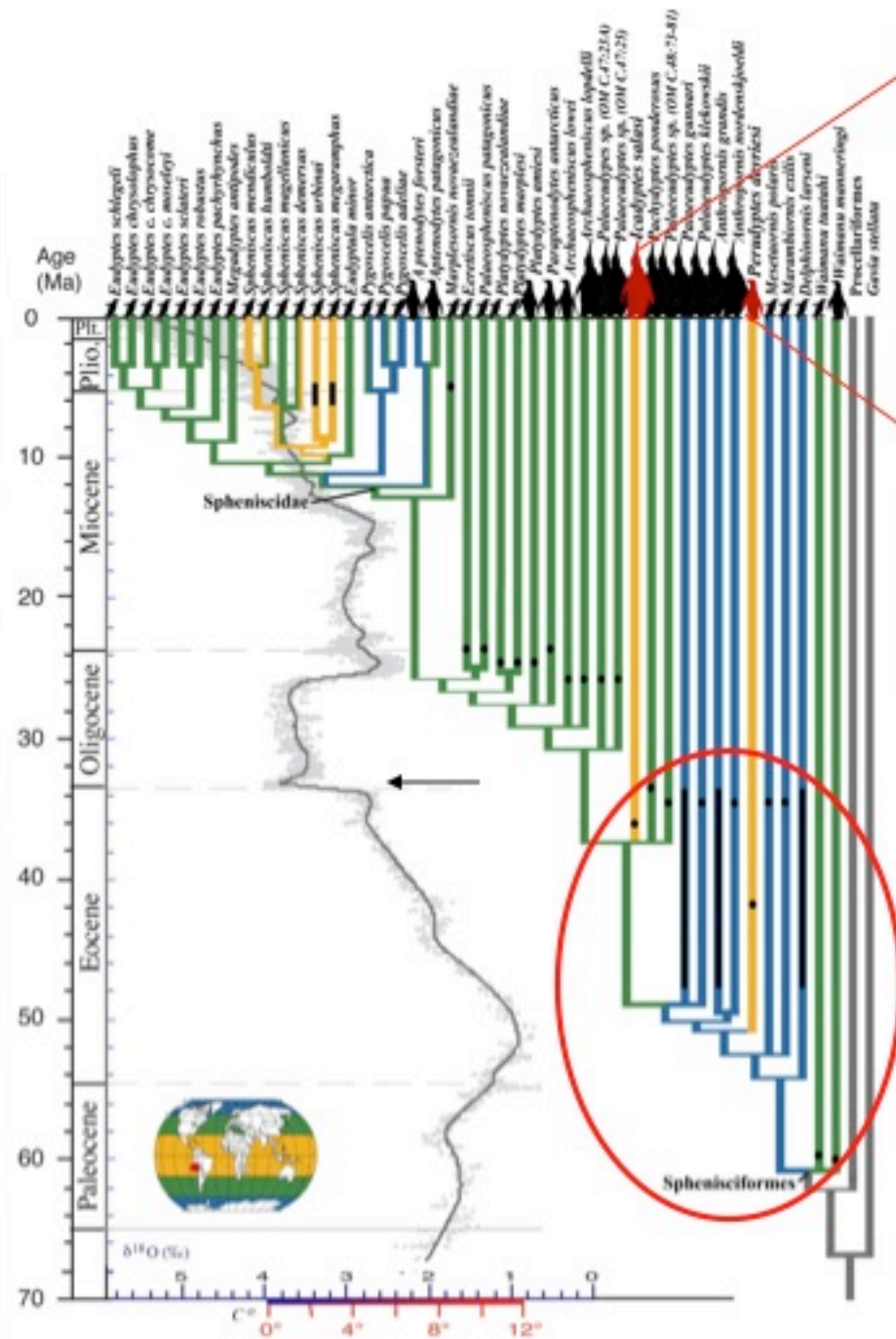
La Meseta Fr.  
various authors



Slack et al., 2006

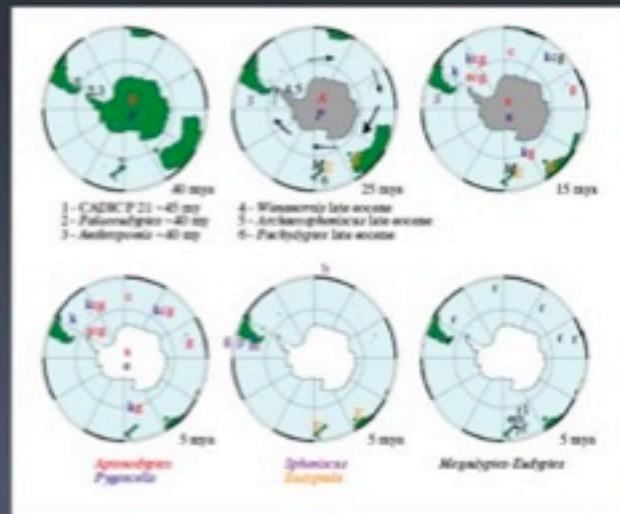


P  
a  
l  
e  
o  
c  
e  
n  
e



**Two separate  
invasions of low  
latitudes in the Eocene**

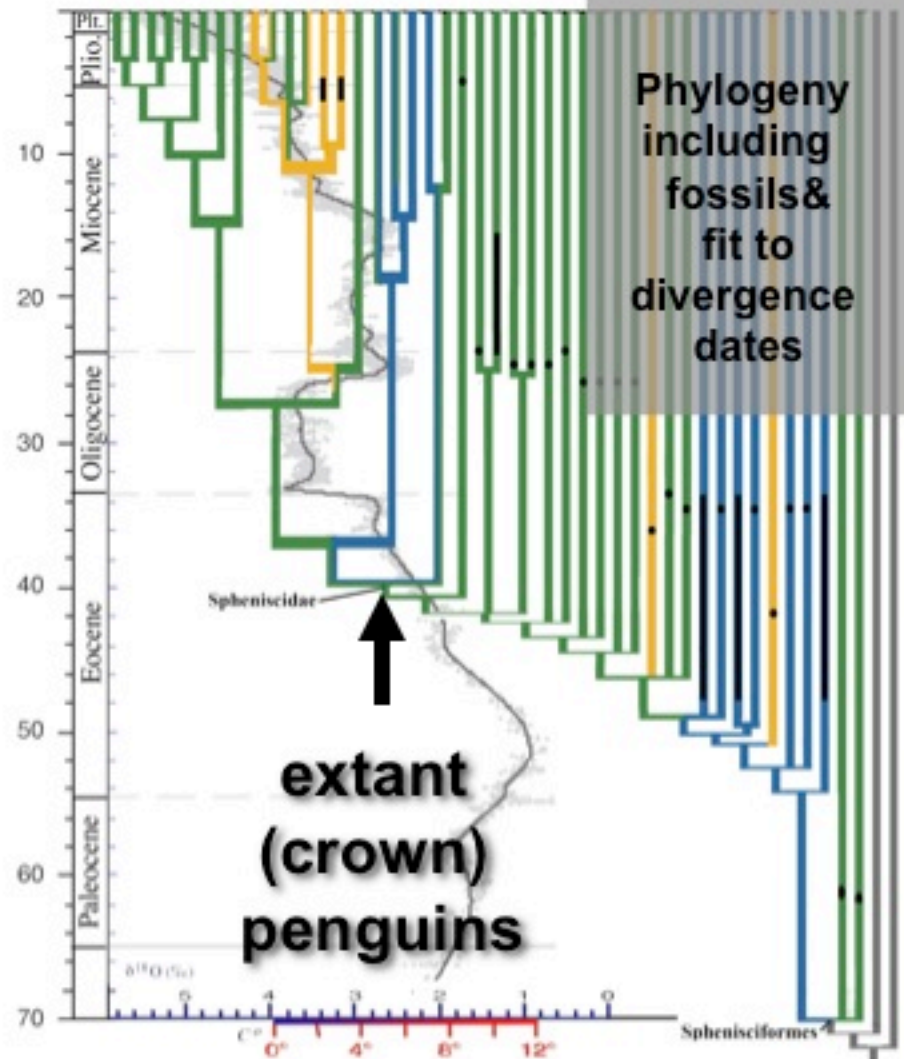
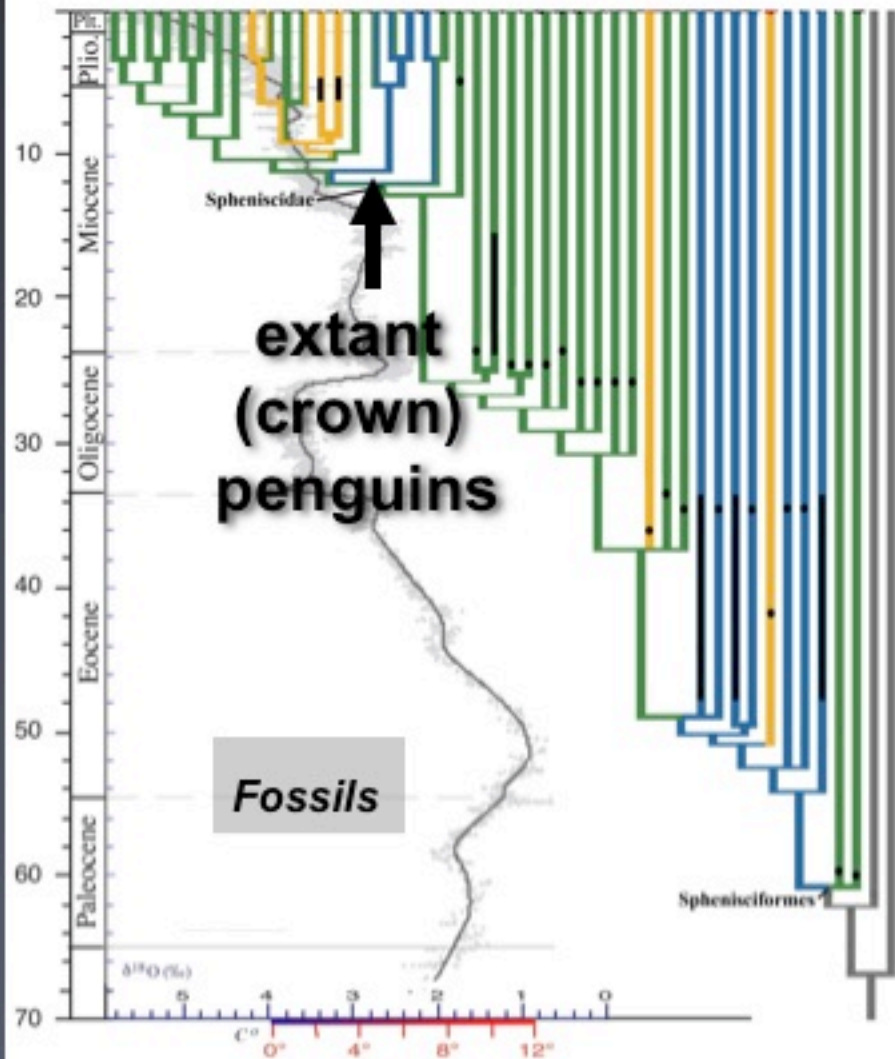
# Expansion of extant penguins out of Antarctica with global cooling- *Baker et al., 2005*



- molecular divergence dating
- Cooling driving penguin dispersal to low latitudes



**172-205% Increase in missing fossil record to enforce divergence dates (from external calibrations; right)**



# Conclusions

- Coliiformes: limited African distribution is a product of the last 34 Ma. Extant diversity not yet known pre- Pliocene.
- Coracii: -- Limited extant distribution (extinction in NA) postdates 51 Ma.
- Sphenisciformes: arguably best record in crown birds. Earliest parts of extant diversity ~15 Ma.
- And, passerines, puffins....?

# Conclusions

- Neogene drivers for extant diversities and distributions... even for ancient stem clades. An ice house avifauna?
- Major Eocene radiations of basal forms diverse in morphology, abundance and biogeographical distributions
- Disjunct between molecular divergence dates and fossil record is massive. New collaborations are underway to address this pattern.

# Acknowledgments

Postdoctoral researchers: D. Ksepka, S. Nesbitt

Graduate students: A. Smith, C. Boyd, D. Eddy, A.J. DeBee, Z. Li

Undergraduate researchers: B. Smith, D. Lawver, C. Torres, L. Wittington, K. Best.

Other colleagues and collaborators : D. Briggs, L. Grande, R. Prum, B. Breithaupt, T. deVries, M. Stucchi, R. Salas, A. Altamirano, S. Bertelli, N. Gianinni, G. Mayr, M. Urbina, Y. Narvaez, M. Norell.

Funding: National Science Foundation (EAR, OISE), National Geographic Society, University of Texas, Austin JSG John A. Wilson Fellowship.