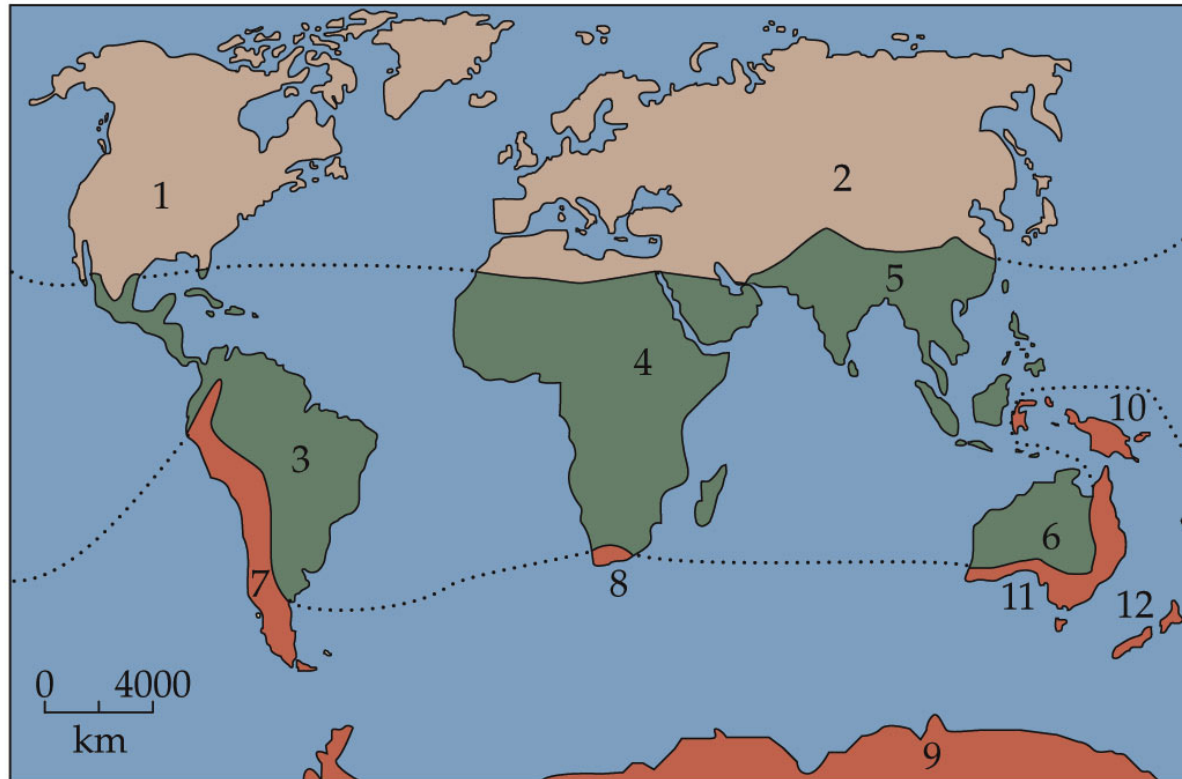


4) Congruence between the histories of lineage and of place



Holarctic Realm (= Laurasia)

- 1 Nearctic Region
- 2 Palearctic Region

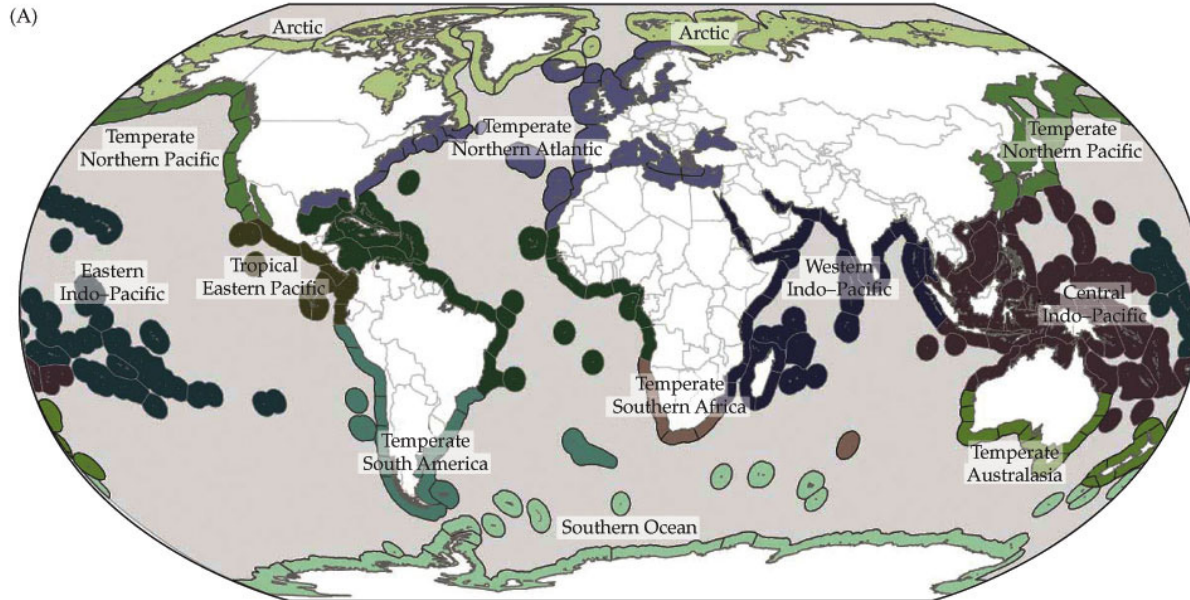
Holotropical Realm (= eastern Gondwana)

- 3 Neotropical Region
- 4 Afrotropical Region
- 5 Oriental Region
- 6 Australotropical Region

Austral Realm (= western Gondwana)

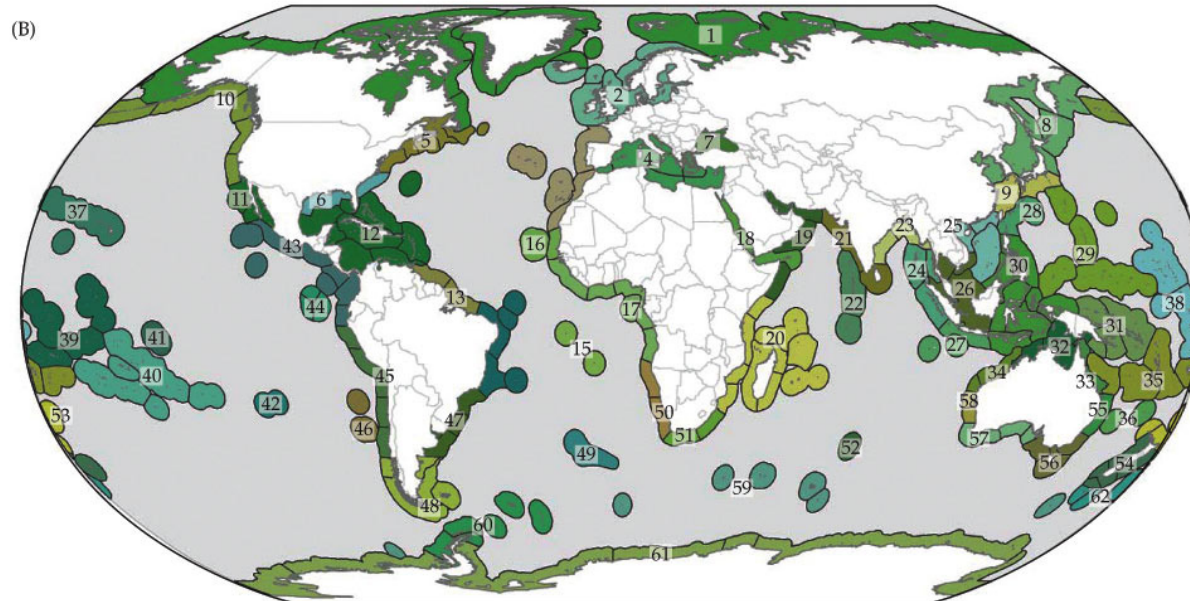
- 7 Andean Region
- 8 Cape or Afrotemperate Region
- 9 Antarctic Region
- 10 Neoguinean Region
- 11 Australotemperate Region
- 12 Neozelandic Region

Marine Realms (Spalding 2007)



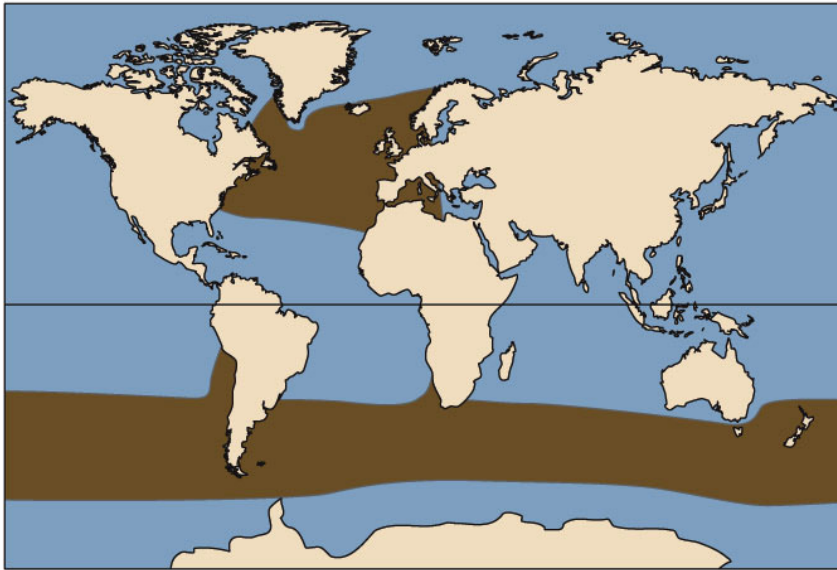
List of Provinces within Realms:

- Arctic Realm
- 1. Arctic (no provinces identified)
- Temperate Northern Atlantic Realm
- 2. Northern European Seas
- 3. Lusitanian
- 4. Mediterranean Sea
- 5. Cold Temperate Northwest Atlantic
- 6. Warm Temperate Northwest Atlantic
- 7. Black Sea
- Temperate Northern Pacific
- 8. Cold Temperate Northwest Pacific
- 9. Warm Temperate Northwest Pacific
- 10. Cold Temperate Northeast Pacific
- 11. Warm Temperate Northeast Pacific
- Tropical Atlantic Realm
- 12. Tropical Northwestern Atlantic
- 13. North Brazil Shelf
- 14. Tropical Southwestern Atlantic
- 15. St. Helena and Ascension Islands
- 16. West African Transition
- 17. Gulf of Guinea
- Western Indo-Pacific
- 18. Red Sea and Gulf of Aden
- 19. Somali/Arabian
- 20. Western Indian Ocean
- 21. West and South Indian Shelf
- 22. Central Indian Ocean Islands
- 23. Bay of Bengal
- 24. Andaman
- Central Indo-Pacific
- 25. South China Sea
- 26. Sunda Shelf
- 27. Java Transitional
- 28. South Kuroshio
- 29. Tropical Northwestern Pacific
- 30. Western Coral Triangle
- 31. Eastern Coral Triangle
- 32. Sahul Shelf
- 33. Northeast Australian Shelf
- 34. Northwest Australian Shelf
- 35. Tropical Southwestern Pacific
- 36. Lord Howe and Norfolk Islands
- Eastern Indo-Pacific
- 37. Hawaii
- 38. Marshall, Gilbert, and Ellis Islands
- 39. Central Polynesia Cook Islands
- 40. Southeast Polynesia
- 41. Marquesas
- 42. Easter Island
- Tropical Eastern Pacific
- 43. Tropical East Pacific
- 44. Galápagos
- Temperate South America
- 45. Warm Temperate Southeastern Pacific
- 46. Juan Fernández and Desventuradas
- 47. Warm Temperate Southwestern Atlantic
- 48. Magellanic
- 49. Tristan Gough
- Temperate Southern Africa
- 50. Benguela
- 51. Agulhas
- 52. Amsterdam-St Paul
- Temperate Australasia
- 53. Northern New Zealand
- 54. Southern New Zealand
- 55. East Central Australian Shelf
- 56. Southeast Australian Shelf
- 57. Southwest Australian Shelf
- 58. West Central Australian Shelf
- Southern Ocean
- 59. Subantarctic Islands
- 60. Scotia Sea
- 61. Continental High Antarctic
- 62. Subantarctic New Zealand



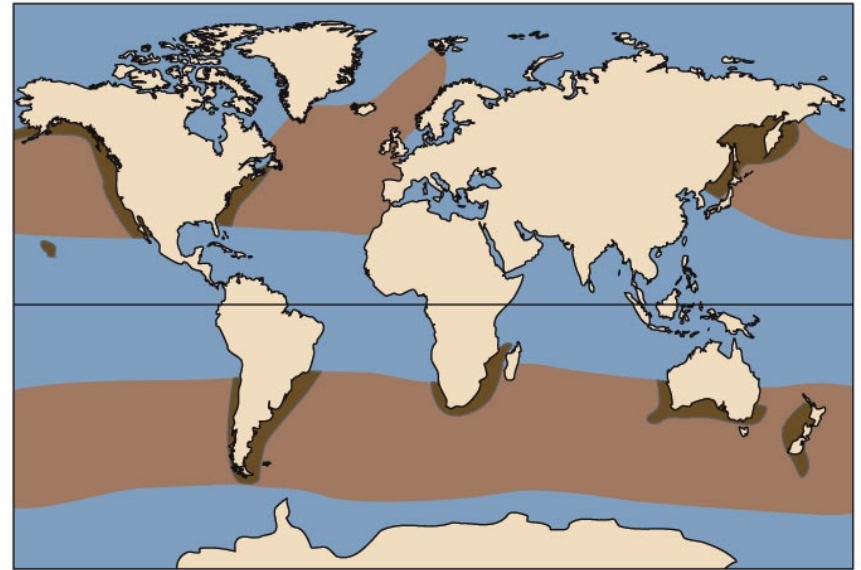
Amphitropical distributions of two whale species

(A)



■ Probable range

(B)



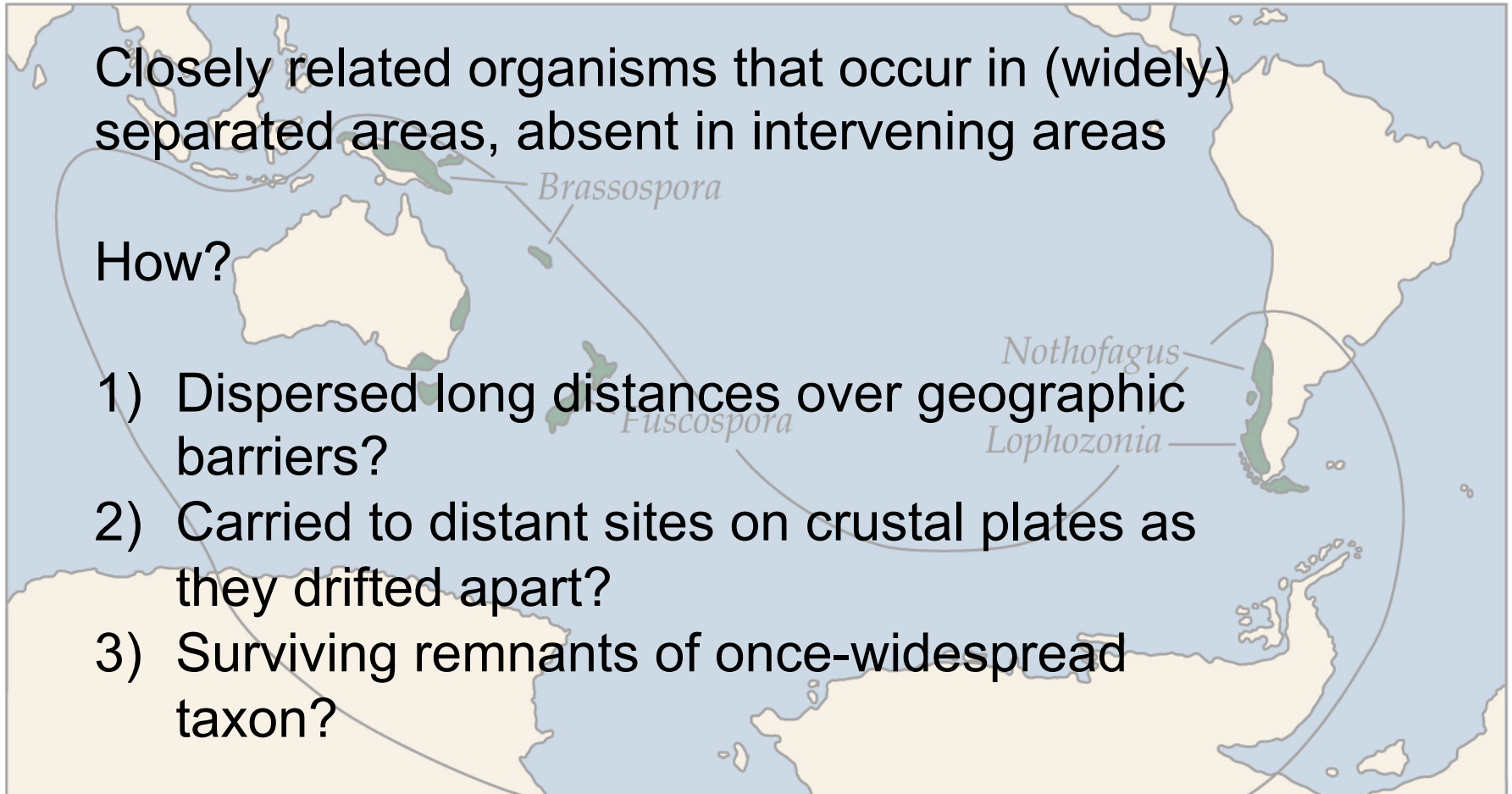
■ Known range
■ Probable range

Disjunctions

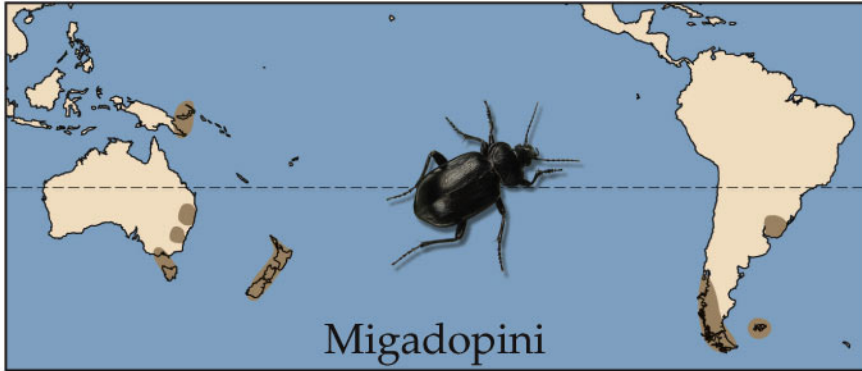
Closely related organisms that occur in (widely) separated areas, absent in intervening areas

How?

- 1) Dispersed long distances over geographic barriers?
- 2) Carried to distant sites on crustal plates as they drifted apart?
- 3) Surviving remnants of once-widespread taxon?



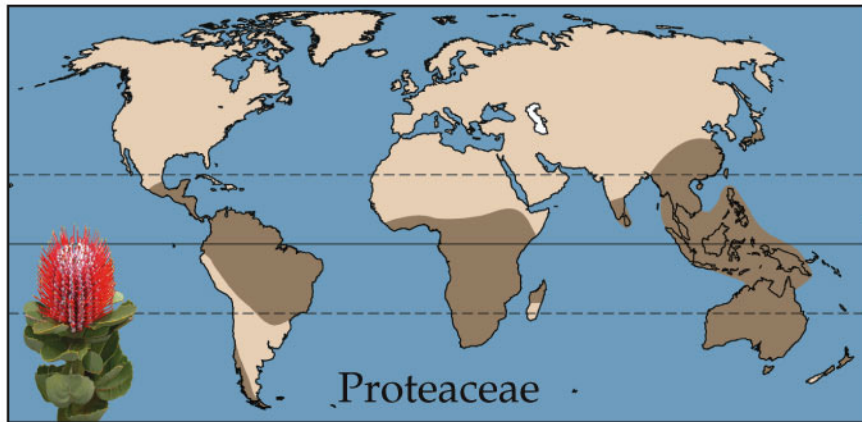
(1)



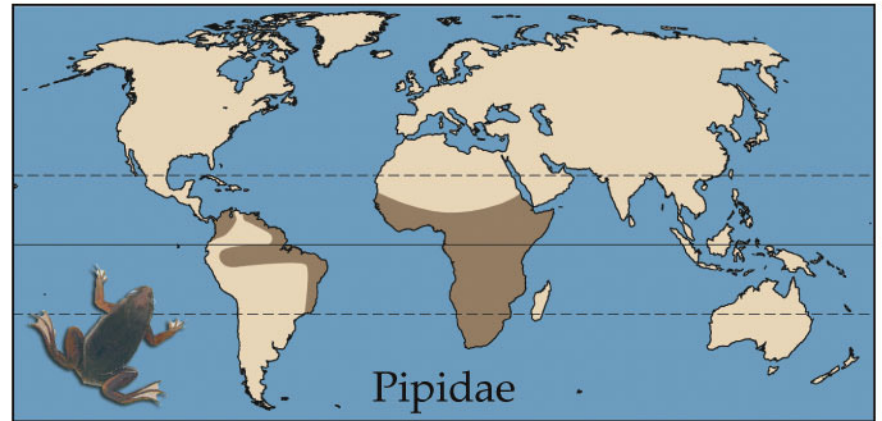
(2)



(3)



(4)





Ostrich (1 sp.)



**Elephant birds
(Extinct)**



Cassowaries (3 spp.)



Tinamous (47 spp.)



Emu (1 sp.)



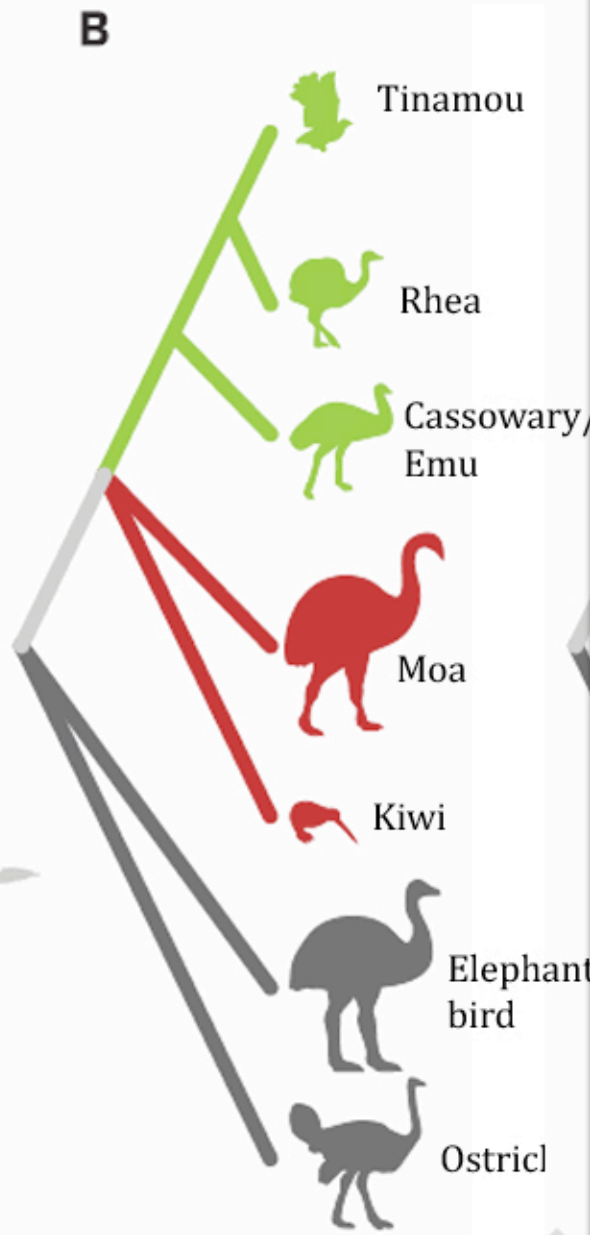
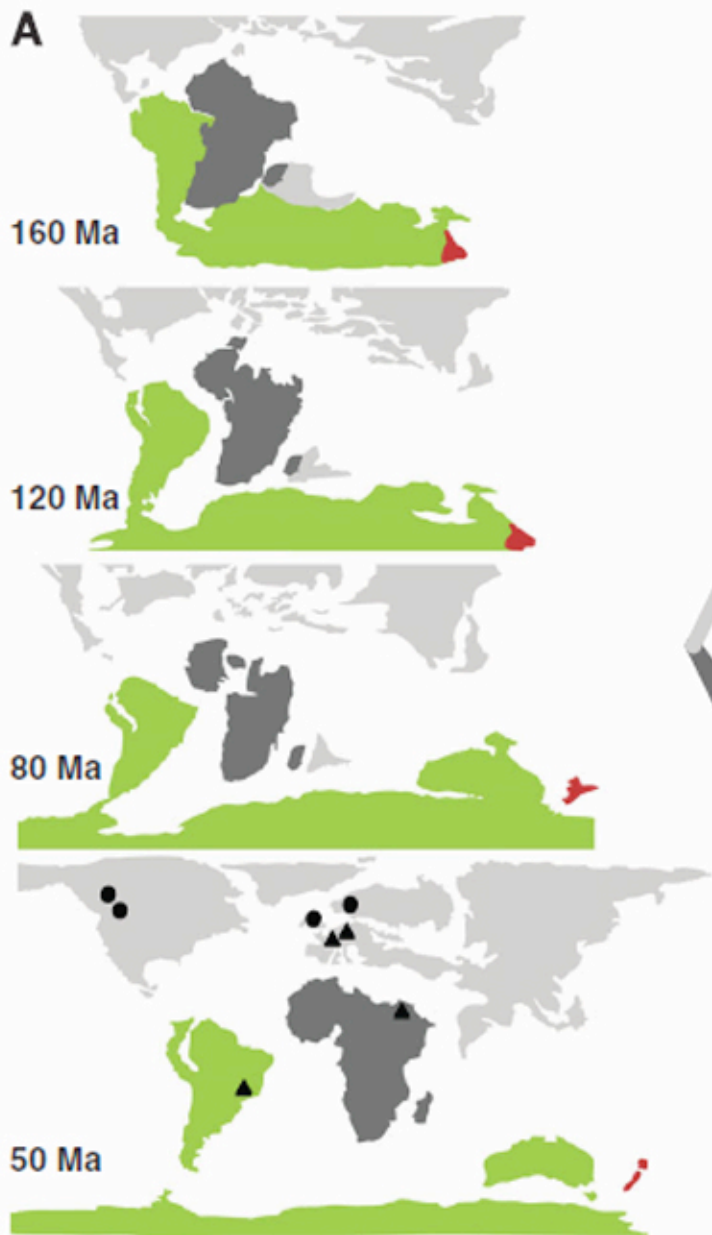
Rheas (2 spp.)



Kiwis (5 spp.)



Moas (Extinct)

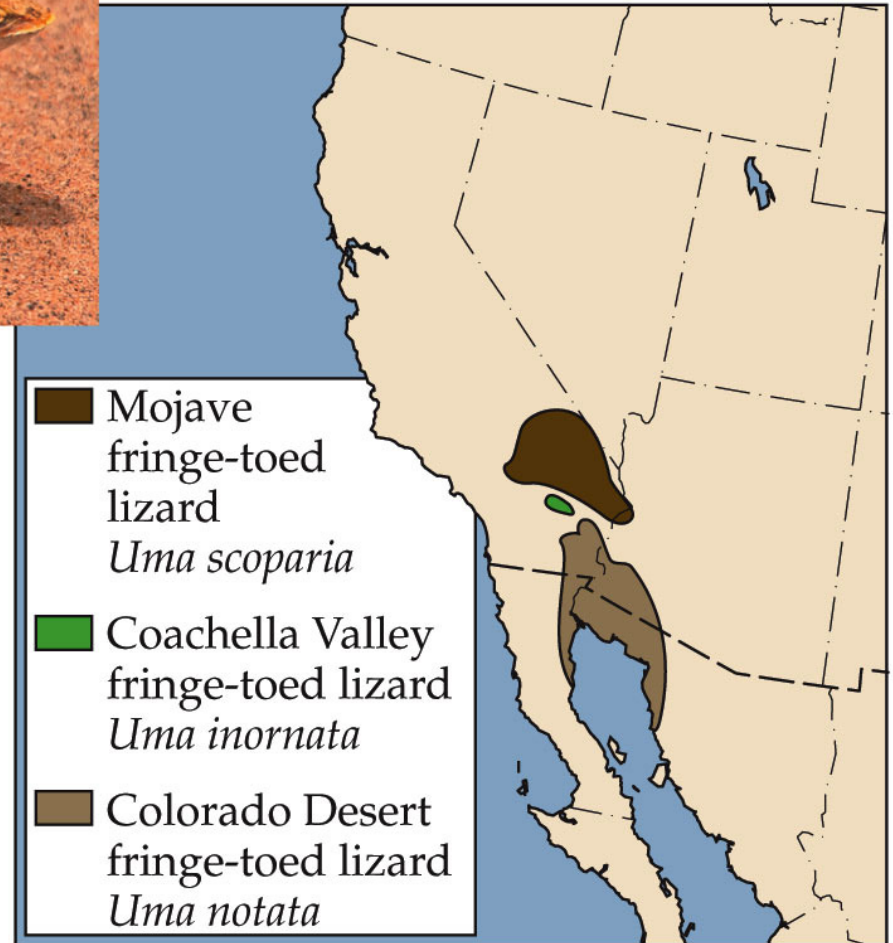




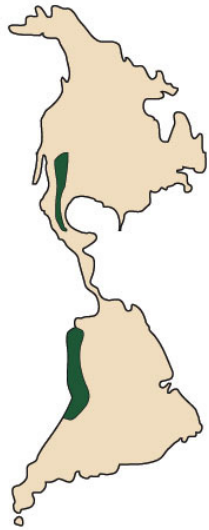
BIOGEOGRAPHY, 4e, Figure 10.27



Uma scoparia



“amphitropical” distribution



Nama dichotomum



Phacelia crenulata



Phacelia magellanica



Agoseris heterophylla, North America
Agoseris coronopifolia, South America



Sanicula crassicaulis



Bowlesia incana



Osmorhiza depauperata (obtusa)



Osmorhiza chilensis

PORCUPINES OF THE WORLD

**BRAZILIAN
PORCUPINE**

Coendou prehensilis



**MALAYAN
PORCUPINE**

Hystrix brachyura



**NORTH
AMERICAN
PORCUPINE**

Erethizon dorsatum



**AFRICAN CRESTED
PORCUPINE**

Hystrix cristata

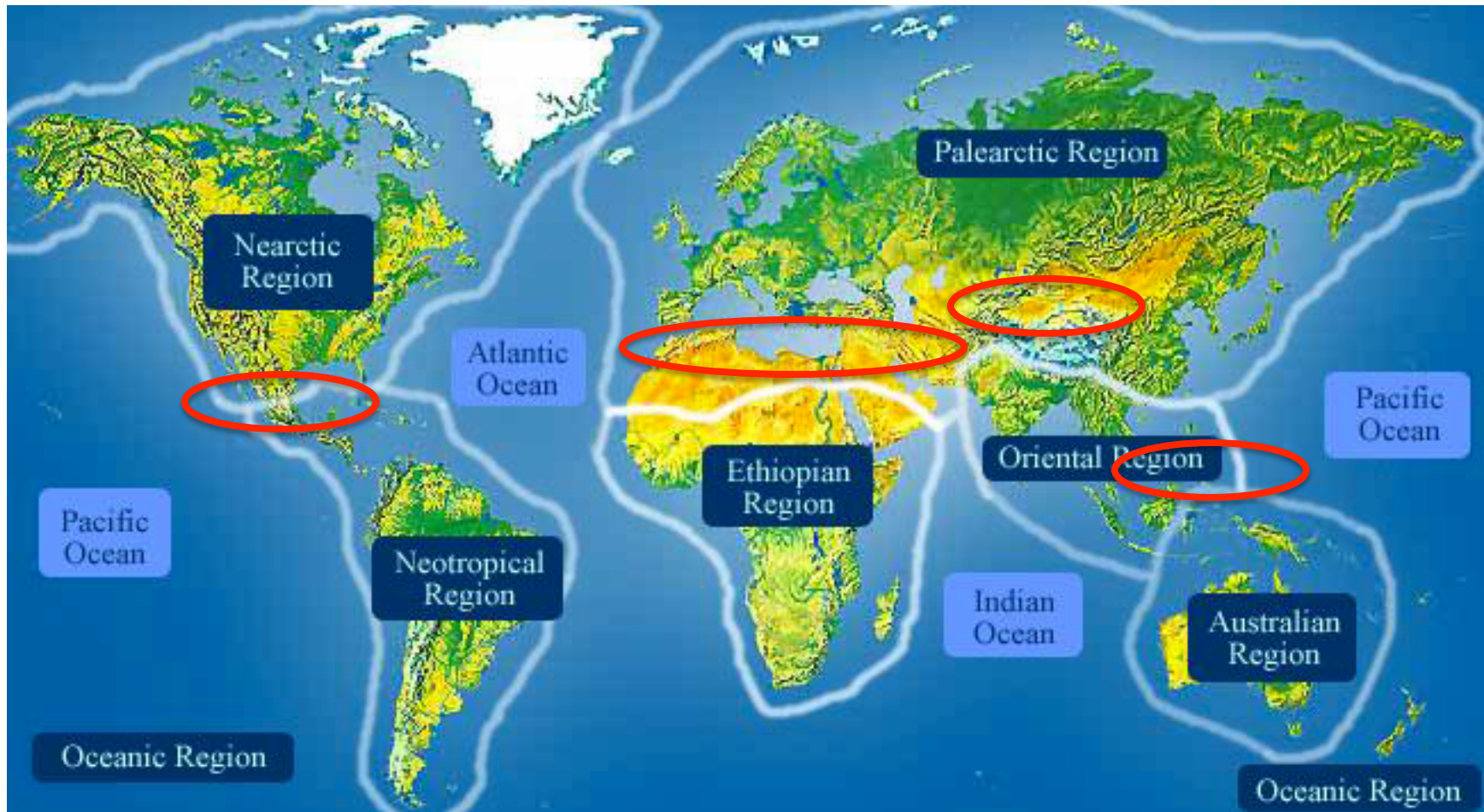


Maintenance of distinct biotas

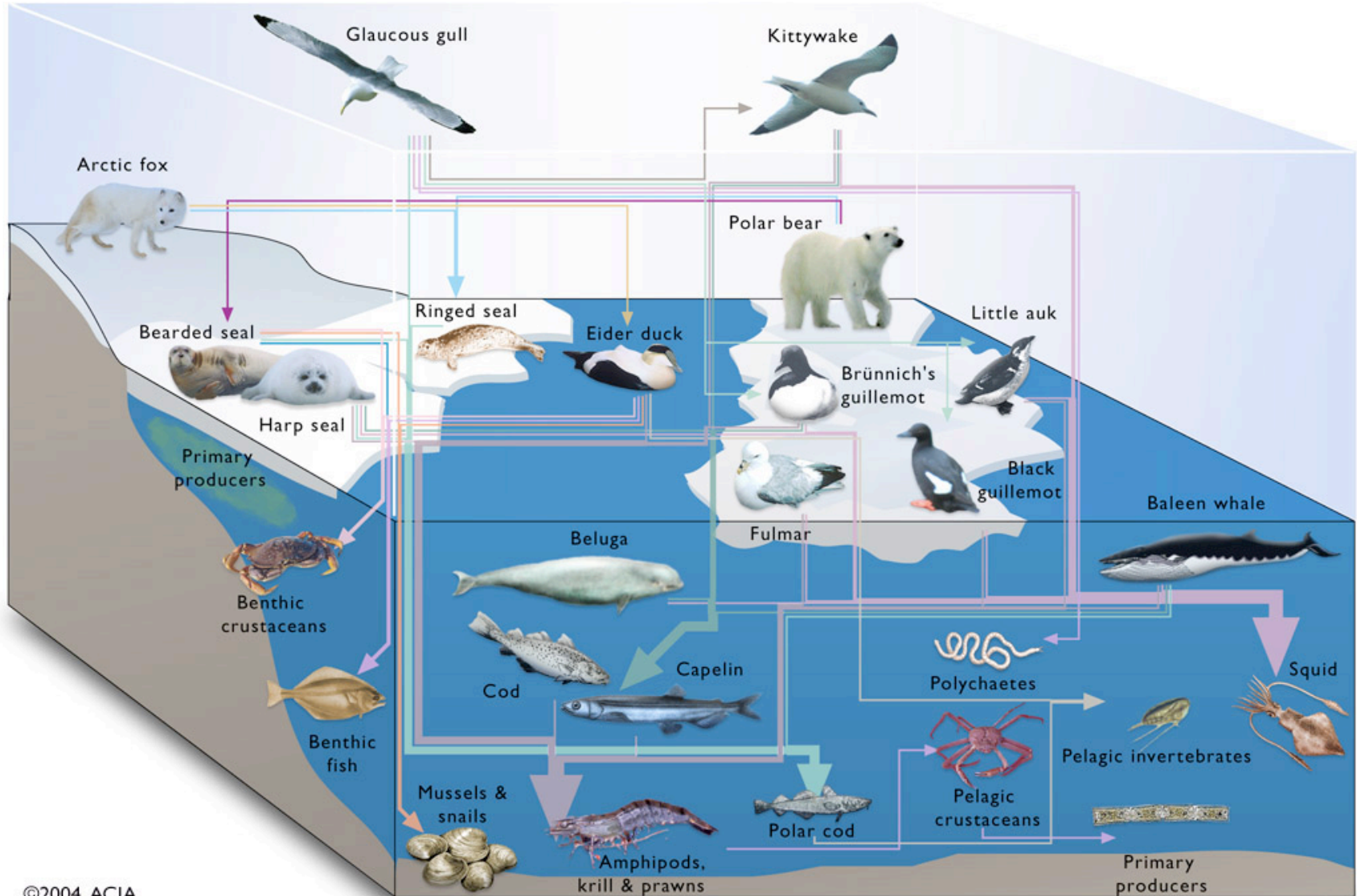
Given the present land bridges connecting Africa and Eurasia, as well as North and South America, and the frequent Pleistocene connections between North America and Eurasia, why hasn't biotic interchange been more complete?

What processes are responsible for the preservation of biogeographic provincialism, especially in organisms that are good dispersers?

1. Barriers between biogeographic regions



2. Resistance to invasion



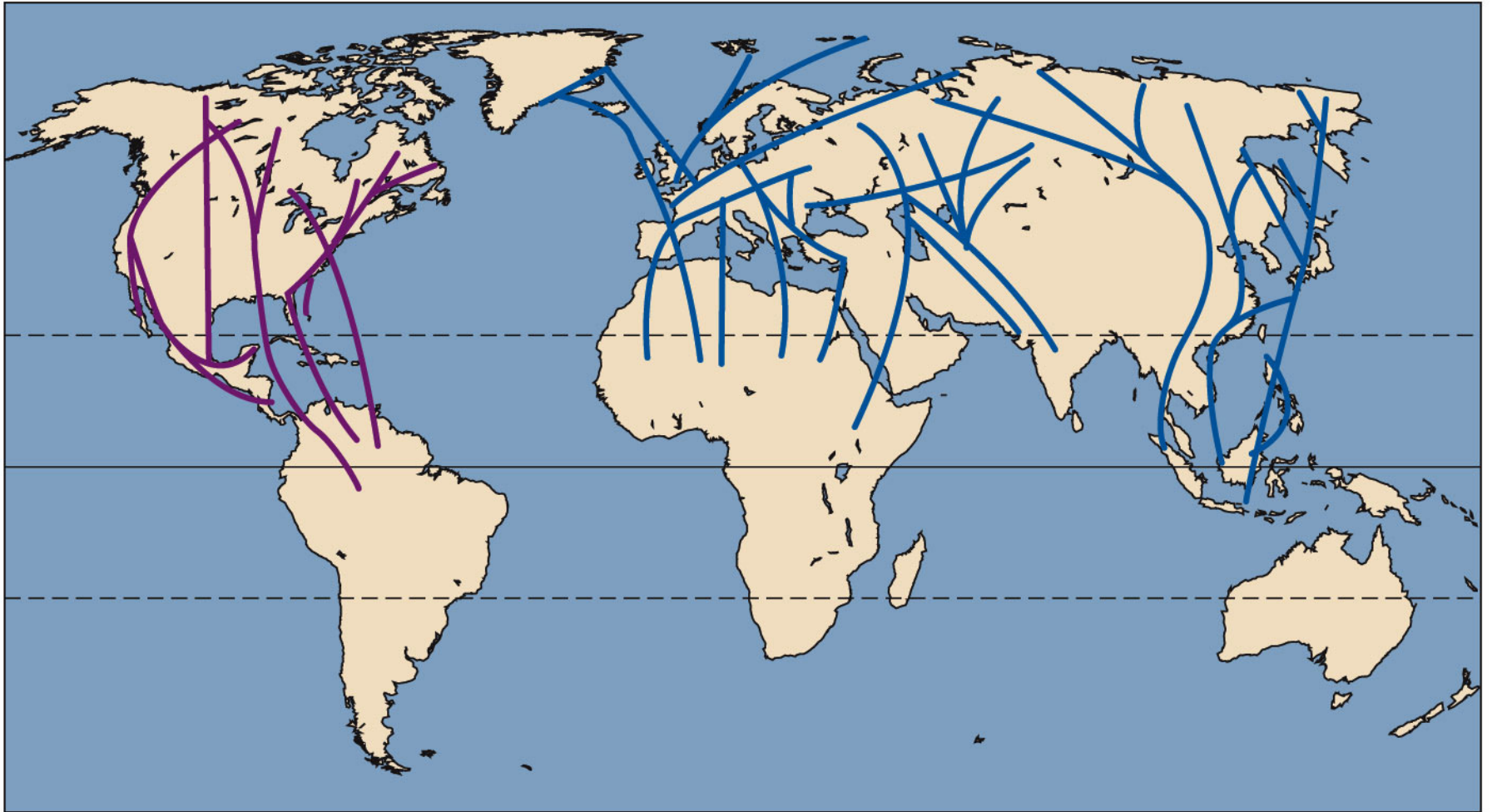
3. Avian migration and provincialism





(A) Arctic warbler (*Phylloscopus borealis*)





BIOGEOGRAPHY, 4e, Figure 10.30



Pipits
(*Anthus*)

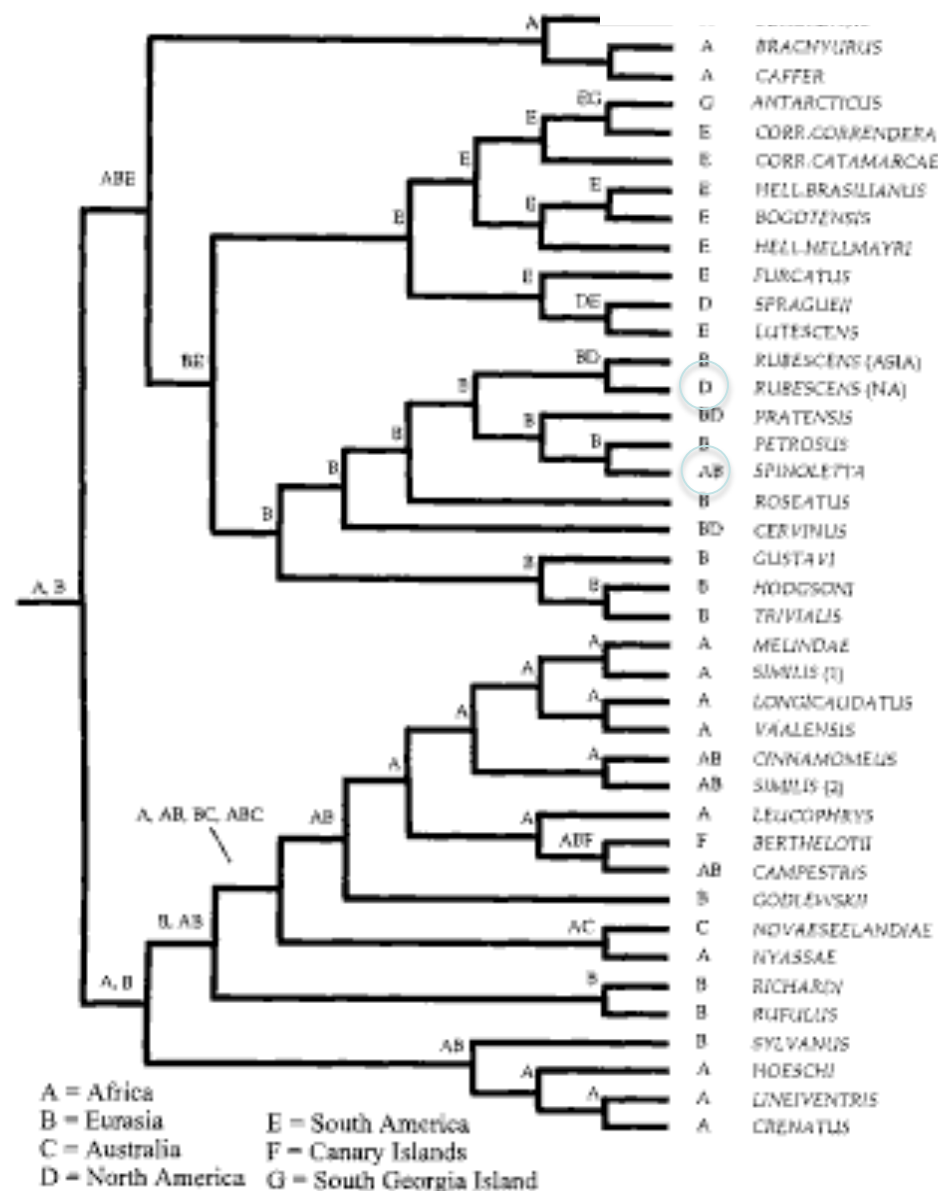
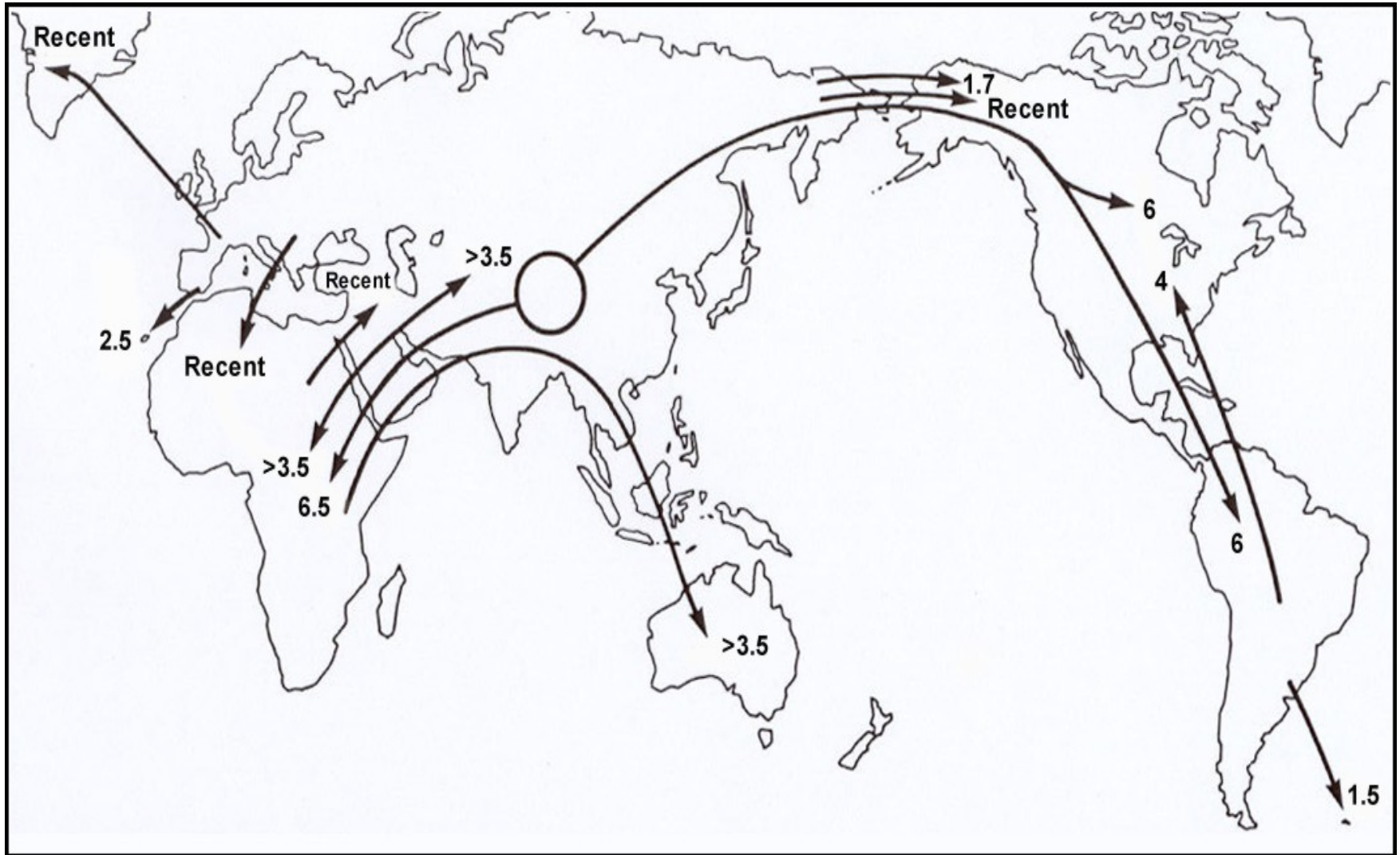


FIG. 5. Ancestral area reconstruction (continent and island level) for all *Anthus* taxa included in this study. Sixteen dispersals are required to explain present distributions (see Table 3).



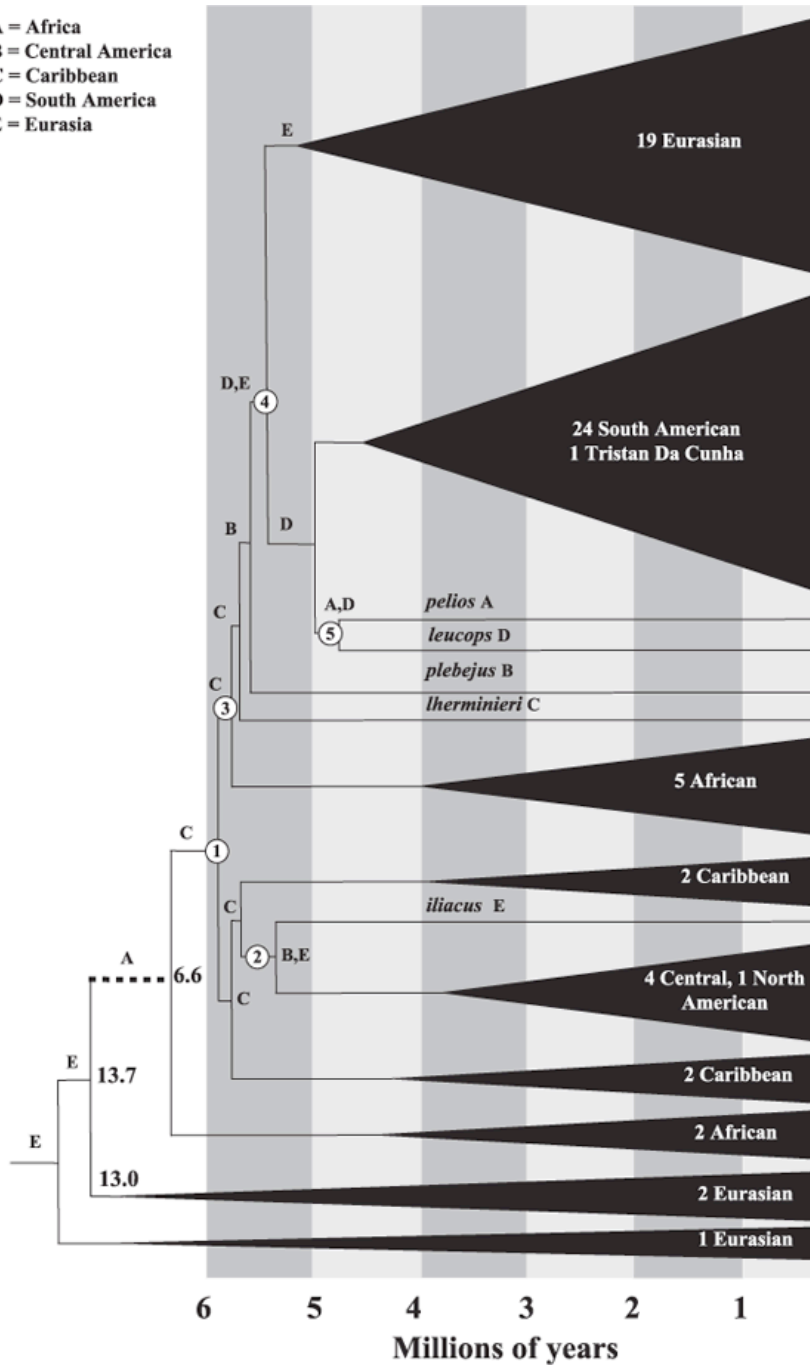
Anthus intercontinental movements

Voelker, G. 1999, *Evolution*



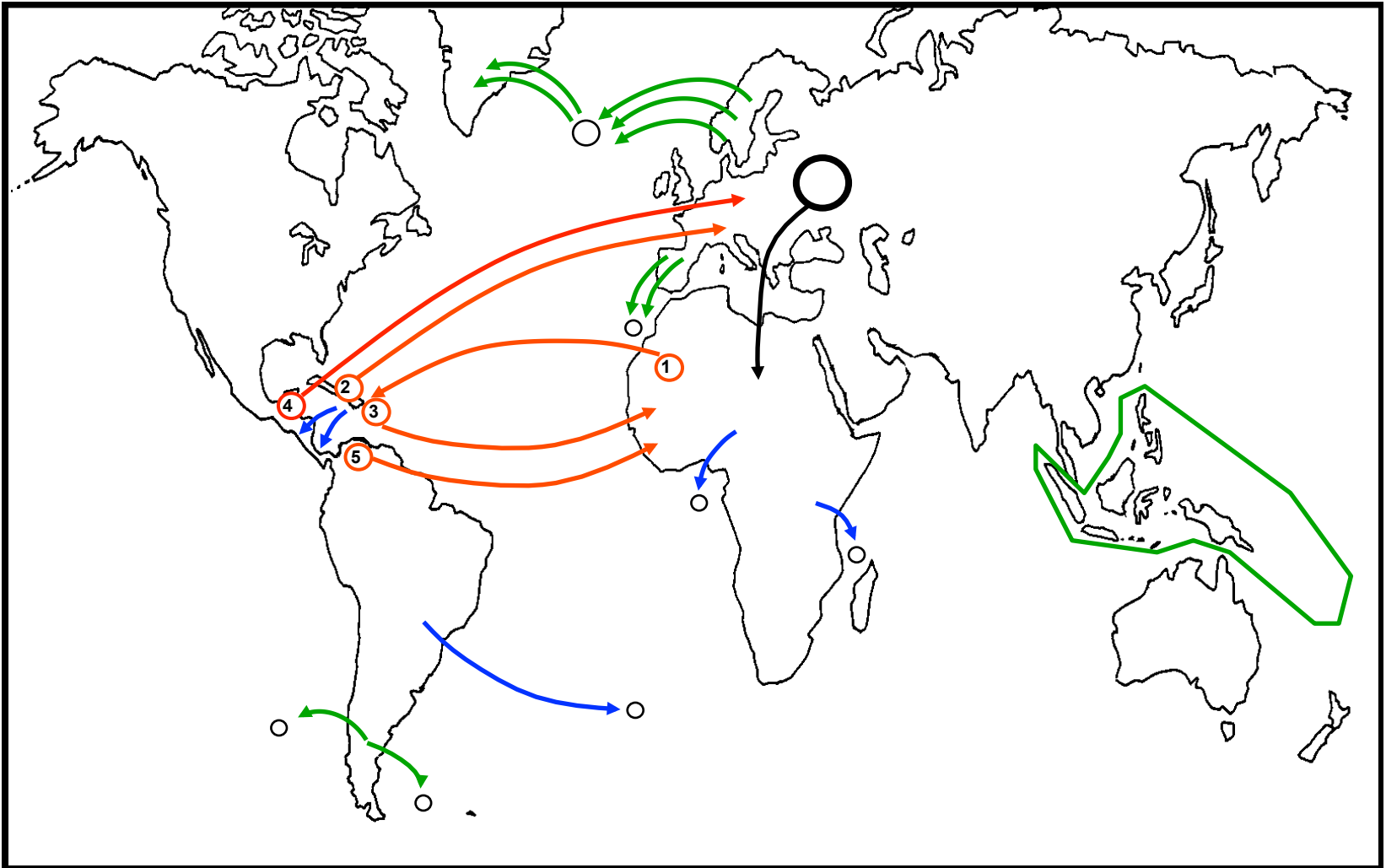
Turdus thrushes,
ca. 65 spp., worldwide

A = Africa
 B = Central America
 C = Caribbean
 D = South America
 E = Eurasia



Voelker, G. 2009.
 Global Ecol. & Biogeo.



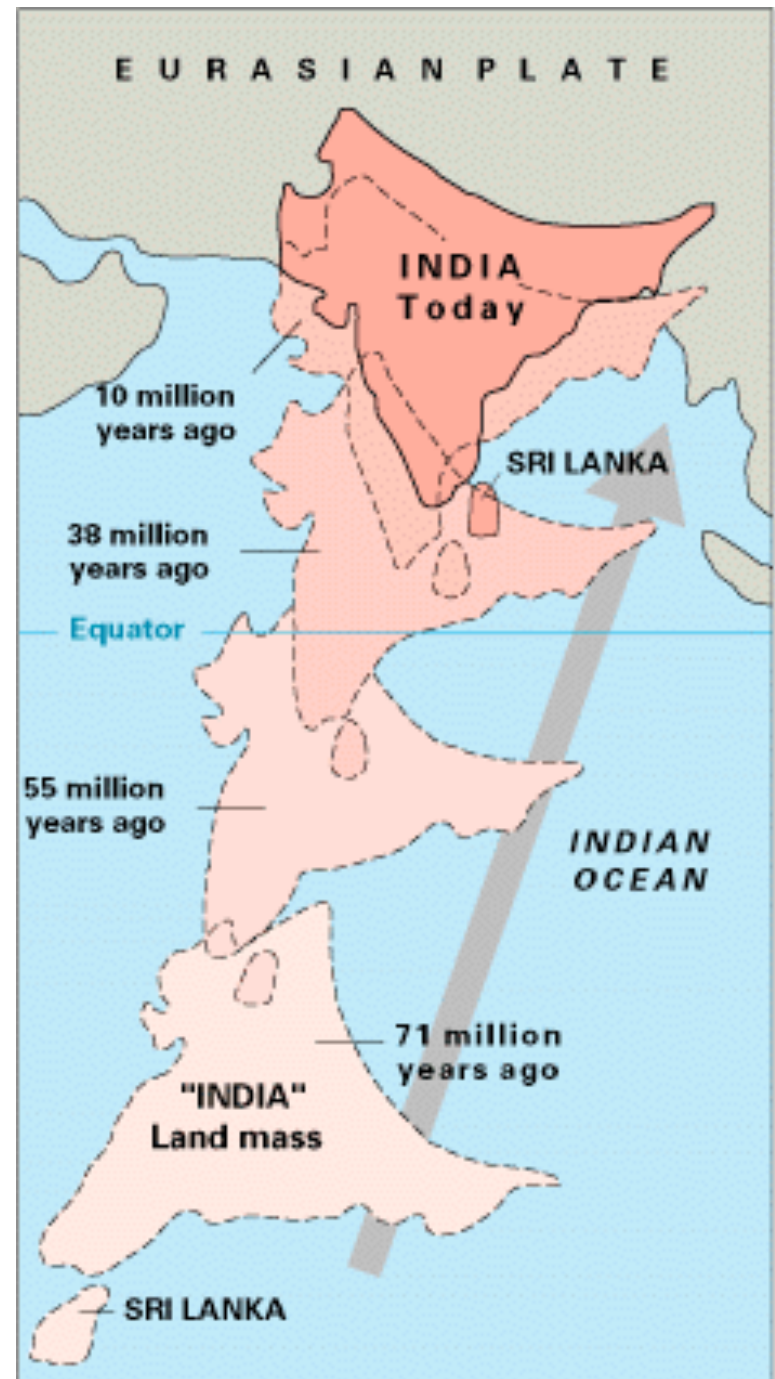


These trans-Atlantic dispersals are a novel result in songbirds...
but how did they do it?

....known climatic patterns across the Atlantic

Biotic interchange

- “opposite” of biogeographic provincialism; a melding of two distinct, previously isolated biotas
- Such contacts have occurred many times historically as continents have drifted over the earth and new land and water connections have been formed
- Unfortunately, records of these events is poor because of limited fossil record

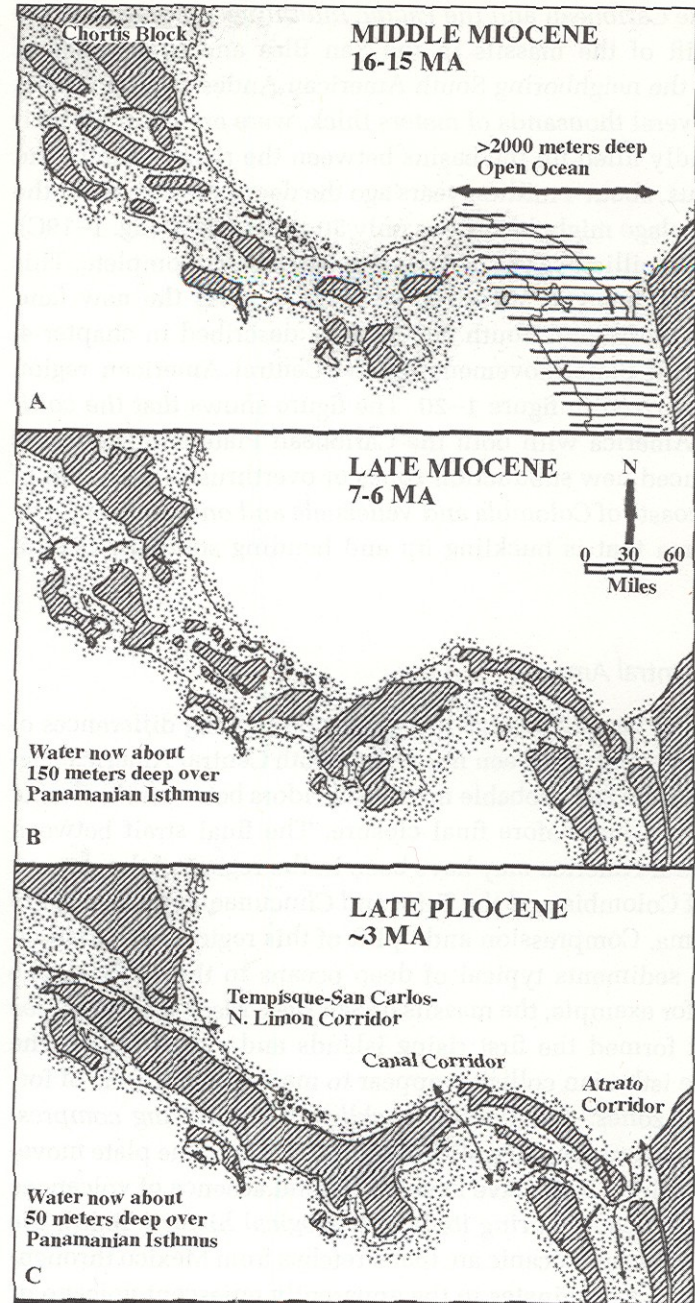




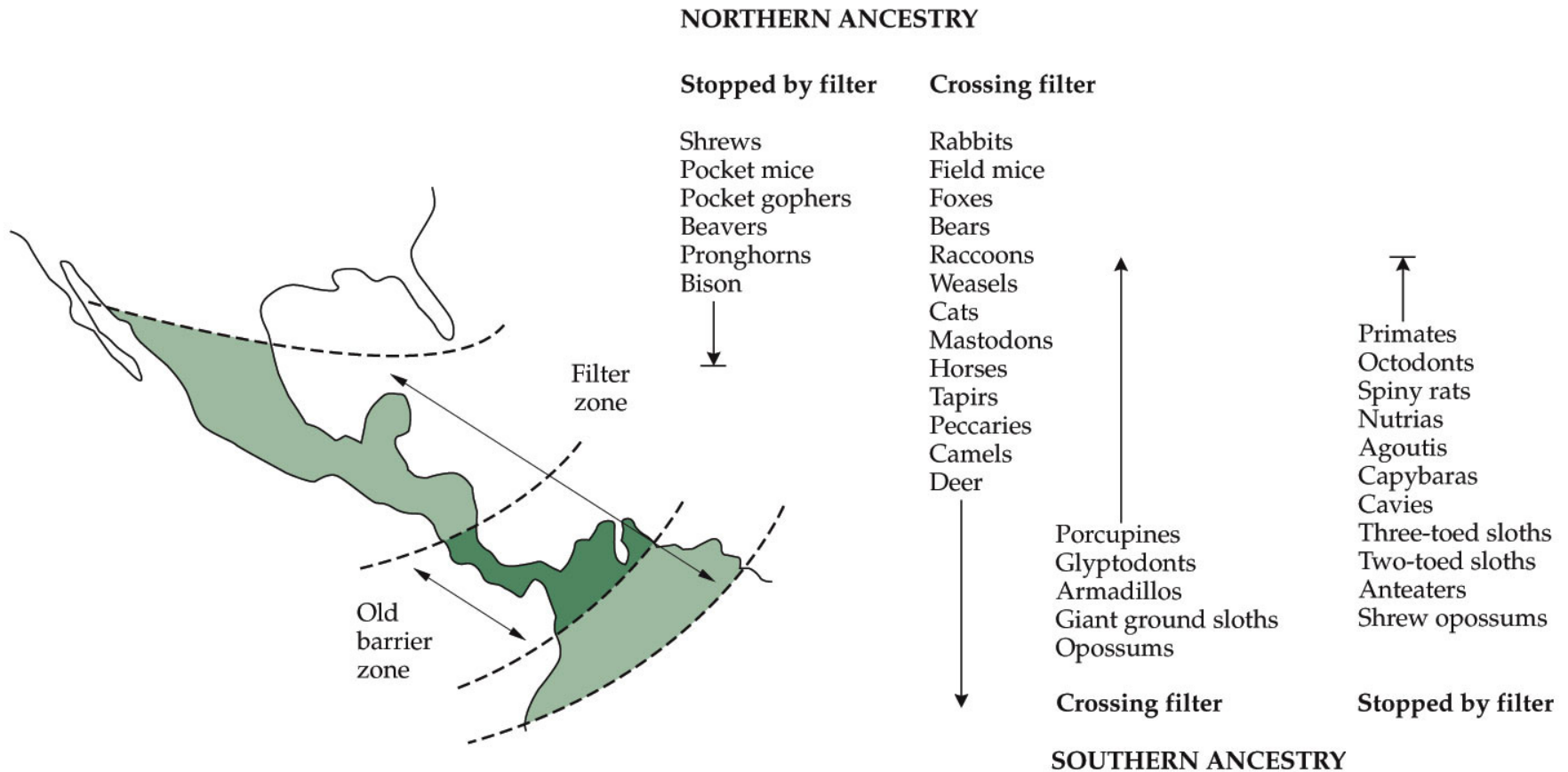
Great American Interchange

“Splendid Isolation”

Great American Interchange



The Great American interchange (mammalian families)





Marshall 1988
American Scientist
76:380-388

Although the percentages of dispersing mammals was similar for the two continents, the North American mammals fared better in South America than their South American counterparts did in North America.

In South America, 50% of the living land mammal species are descended from North American immigrants.

The corresponding figure for South American descendants among North American mammals is less than 10%.

Other notable factors:

All 13 species of endemic South American ungulates went extinct, probably because they were unable to cope with North American carnivores or with competition from North American ungulates.

Many marsupials were replaced by placental mammal “counterparts”



What was the reason for the greater success of the immigrants from North America?

1. Better migrators

2. Better survivors and speciators

3. Better competitors

Physiological constraints (i.e. **niche conservatism**) ??



Table I. Possible Origin and Late Cenozoic Dispersal of Cracidae in the Continental Americas

Authority	North American origin, migration to South America chiefly or only in late Cenozoic after isthmian link	South American origin, interchanges with North America already in early Cenozoic, and possibly late Cenozoic
Mayr (1946, 1964)	×	
Vuilleumier (1965)	×	
Griscom (1950)	× (?)	
Tordoff and Macdonald (1957)	× (?)	
Slud (1960)	× (?)	
Vaurie (1968)	× (?)	
Darlington (1957)		
Haffer (1967)		
Howell (1969)		
Delacour and Amadon (1973)		
Cracraft (1973a)		



Vuilleumier, F. 1985. Fossil and recent avifaunas and the interamerican interchange.
In The Great American Biotic Interchange [Stehli and Webb, eds.]

Exchange in other vertebrates???

...because birds are better over-water colonists than non-volant mammals... This means that some level of faunal interchange between the two continents probably occurred continuously throughout the Cenozoic, rather than being concentrated in the last 2.5 million years following the completion of the Central American land bridge...



In: Biogeography, 3rd ed., 2006. Lomolino, Riddle, and Brown.

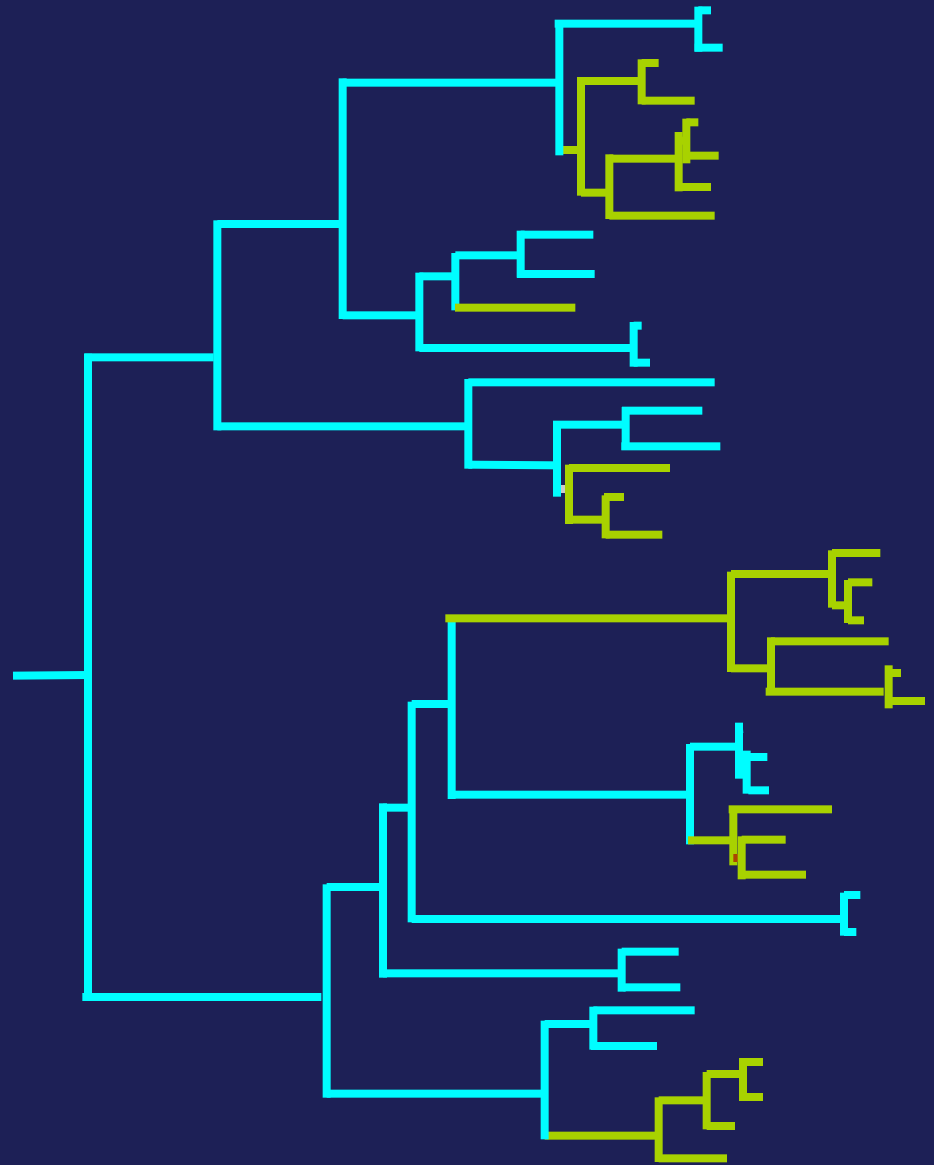
Trogon

17 species, 41 lineages

Distribution:

— = N of Isthmus of Panama

— = S of Isthmus of Panama



DaCosta, J and Klicka, J. 2008. Molecular phylogenetics of *Trogon*: exploring patterns of diversification in a widespread Neotropical avian group. *Molecular Ecology*

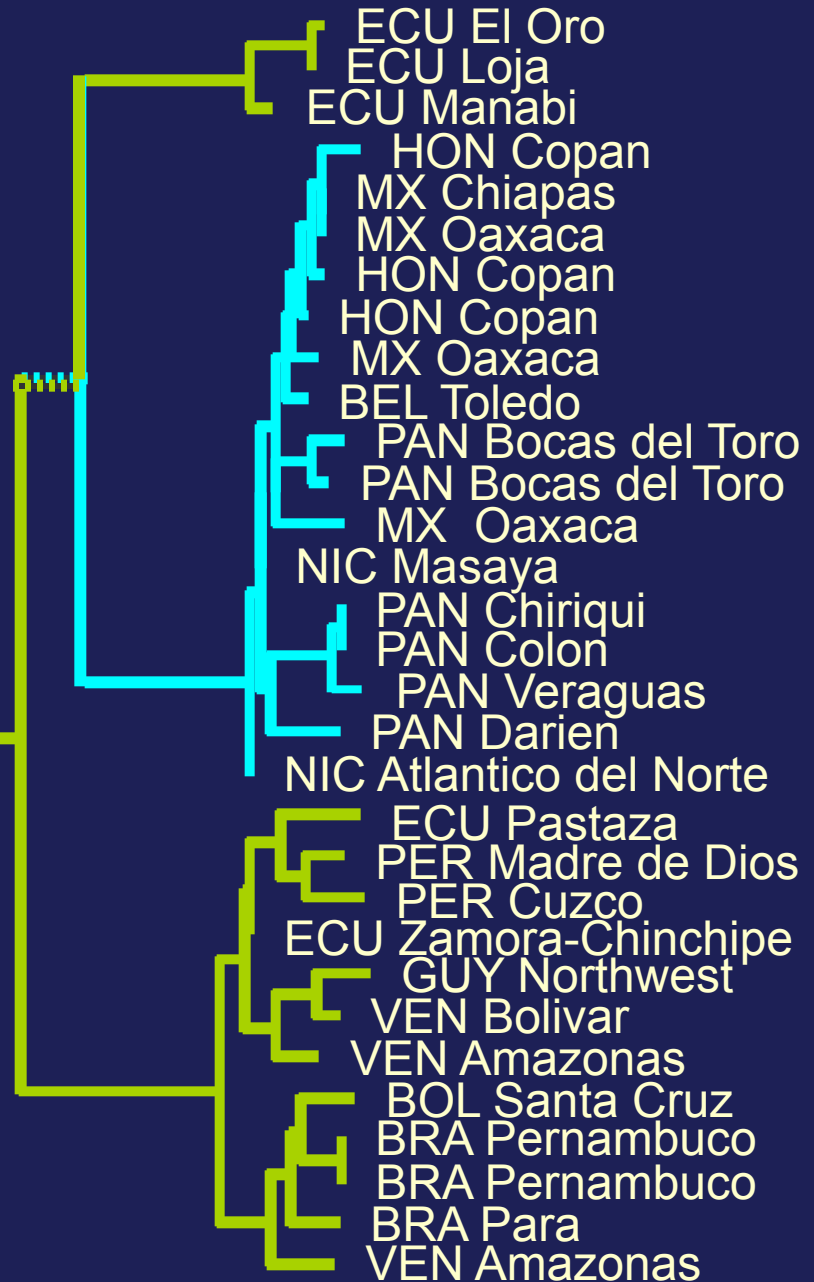
Saltator maximus

3 main lineages

Distribution:

— = N of Isthmus of Panama

— = S of Isthmus of Panama



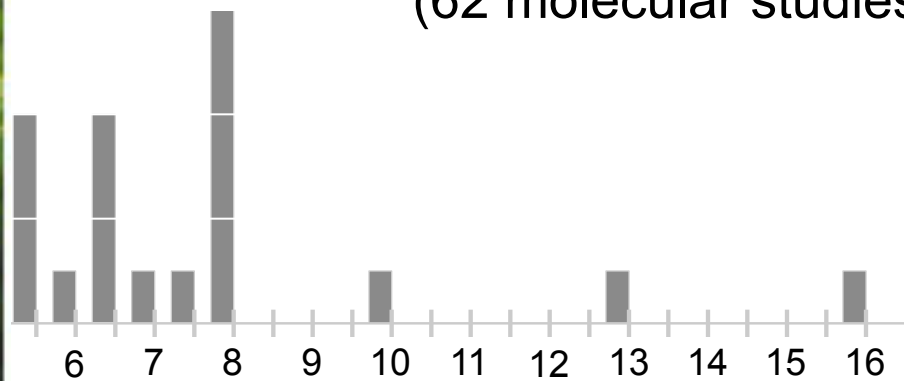
Unpublished data.



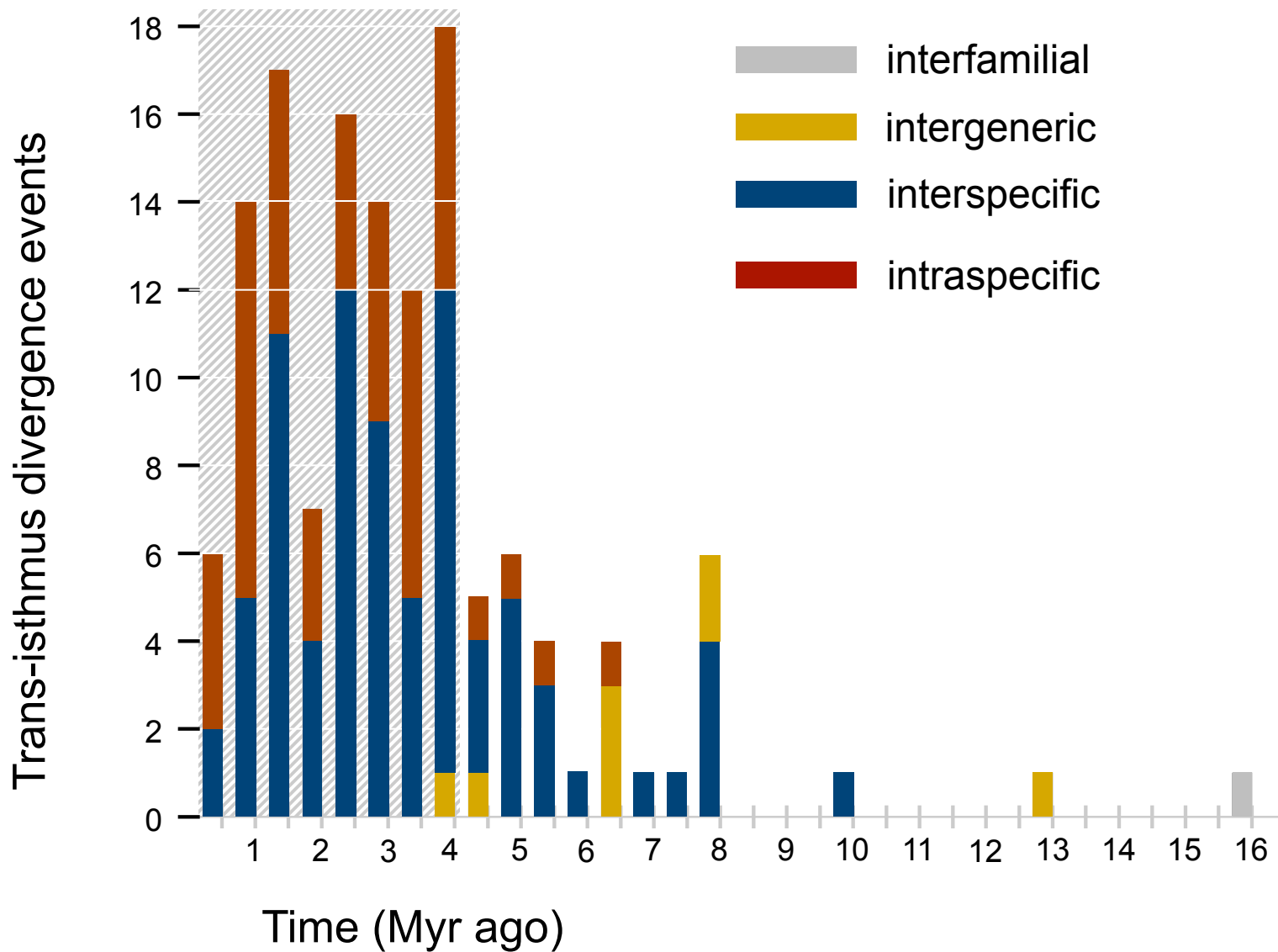
In all.....we tabulate 135 pairs of sister lineages for which one lineage is restricted to a South American distribution and the other to North America

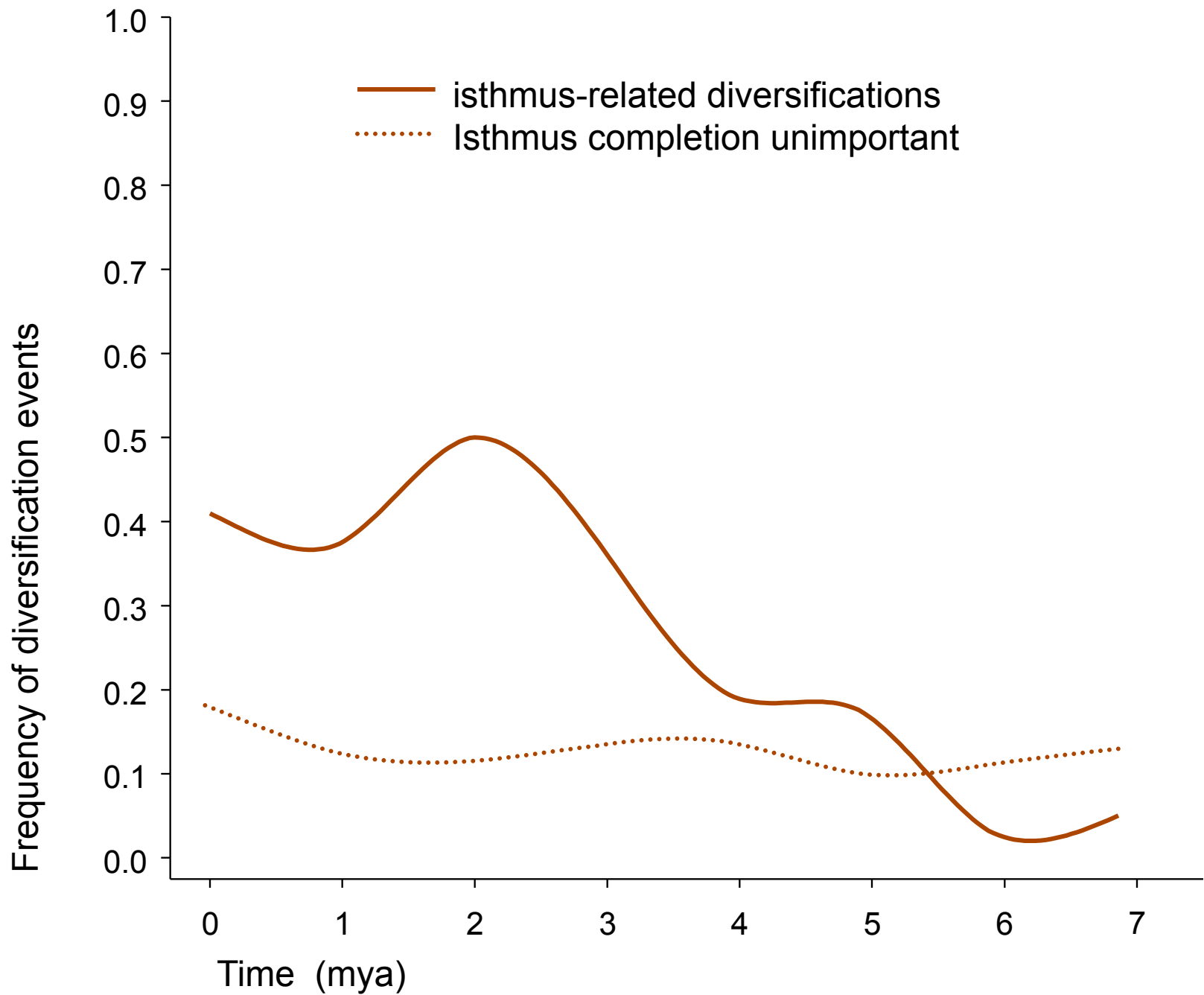
The taxa included were a taxonomically and ecologically diverse lot, with 10 orders, 33 familiesand over 100 genera represented...

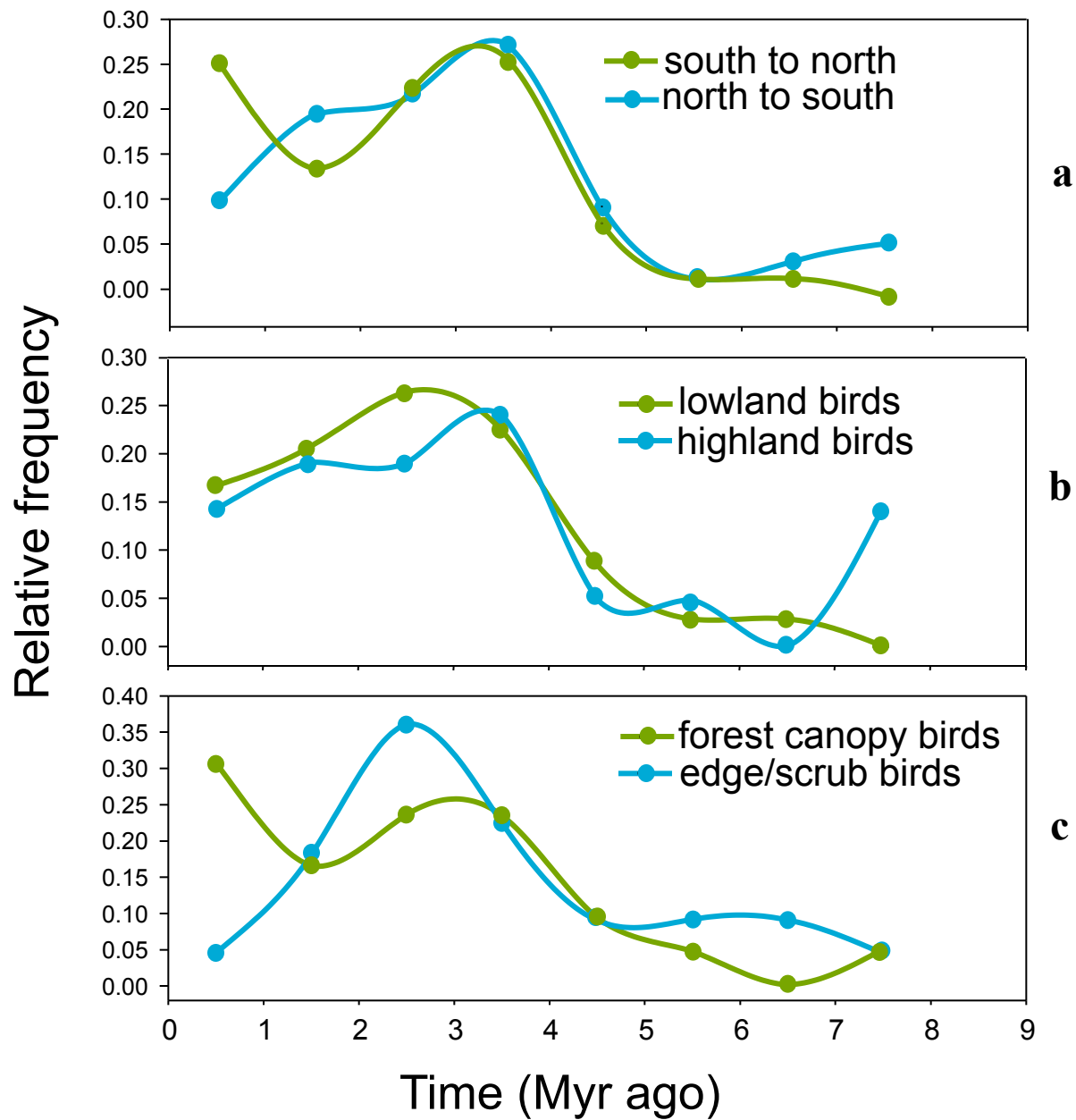
(62 molecular studies)



c)







Summary: Birds and the Great American Interchange

The final uplift of the Panamanian landbridge appears to have played a prominent role promoting diversification within New World birds.

Birds crossing the isthmus were an ecologically diverse group

Within the neotropics, relatively equal exchange in both directions
Highly asymmetrical exchange between temperate and tropical regions

Crossing events were frequently followed by radiations



Exchange in other vertebrates???

...because birds are better over-water colonists than non-volant mammals... This means that some level of faunal interchange between the two continents probably occurred continuously throughout the Cenozoic, than being concentrated in the last 2.5 million years following the completion of the Central American land bridge...

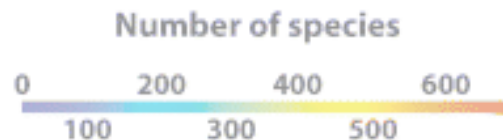


In: Biogeography, 3rd ed., 2006. Lomolino, Riddle, and Brown.

Other stuff from your book that's not true (pp 411-412)

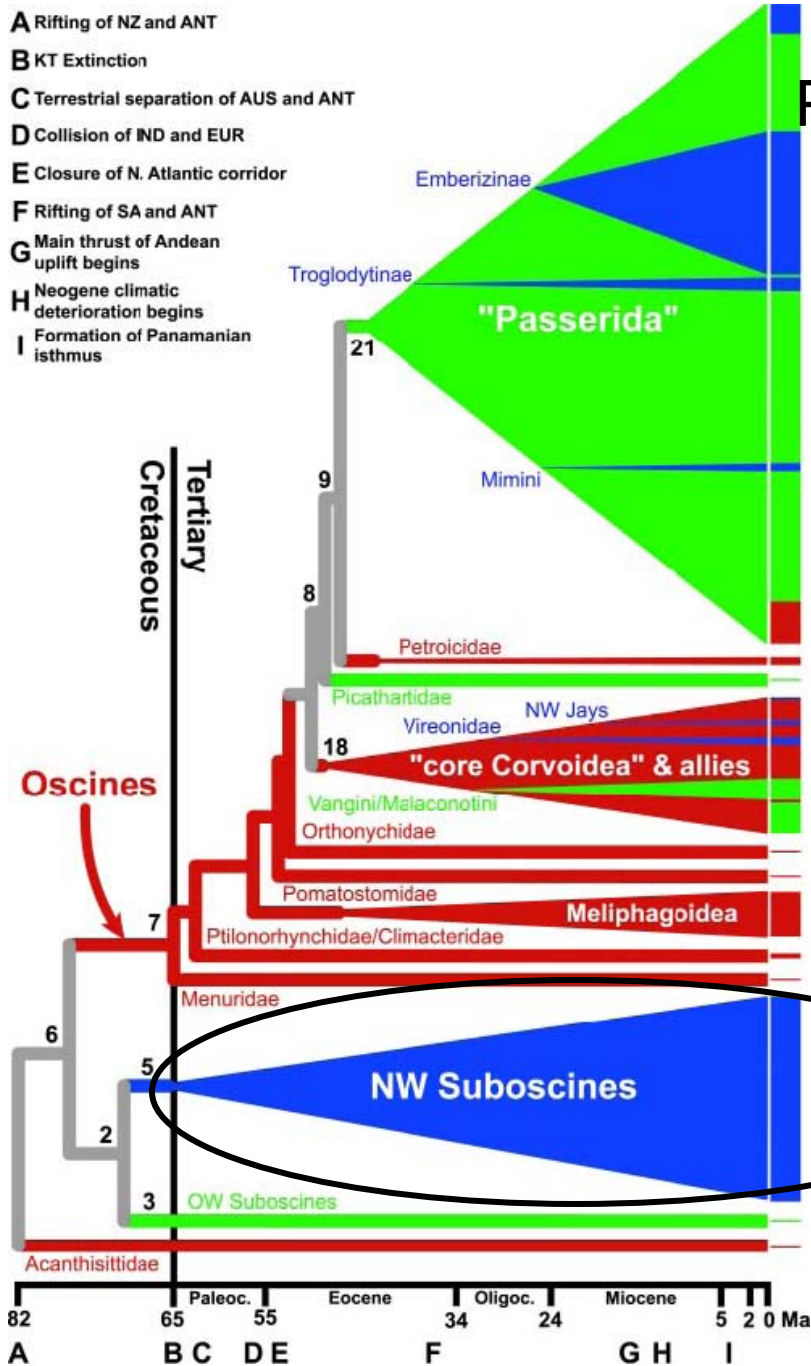
“First, there is no clear dichotomy between an Ancient South American fauna, which dates back to the isolation of Gondwanaland, and relatively recent invaders.....

....Thus, at least for Birds, it is difficult to distinguish easily between South American “natives” and North American “invaders””



Passerine ("songbird") Relationships

5739 species;
over half of all extant avian species



Blue = North and South America
Green = Africa and Eurasia
Red = Australasia

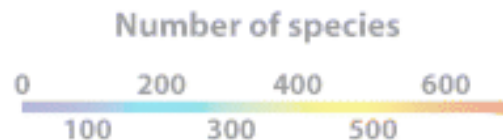
Barker, F. K. et al. 2004. Phylogeny and diversification of the largest avian radiation. PNAS.



Other stuff from your book that's not true (pp 411-412)

“While some groups such as pigeons, owls, woodpeckers, and jays, colonized South America from the North, other groups, such as hummingbirds, tyrant flycatchers, vireos, wood warblers, blackbirds, orioles, tanagers, and emberizine buntings (grosbeaks and sparrows) moved in the opposite direction”

“An interesting feature of the North American avifauna is that the Neotropical migrants, which make up the majority of breeding passerines in temperate habitats, are virtually all of South American ancestry.”



Emberizidae

Parulidae

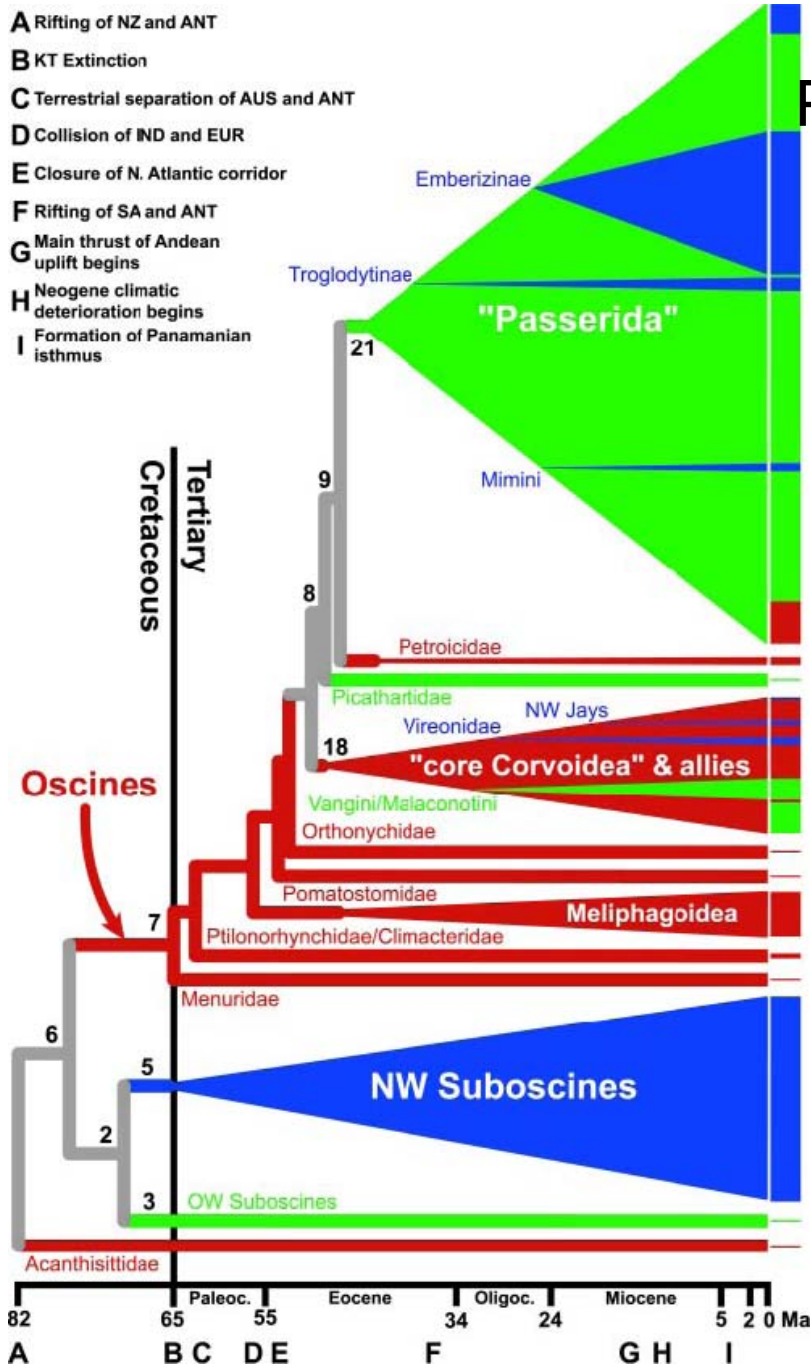
Icteridae

Cardinalidae Thraupidae



Passerine (“songbird”) Relationships

5739 species;
over half of all extant avian species

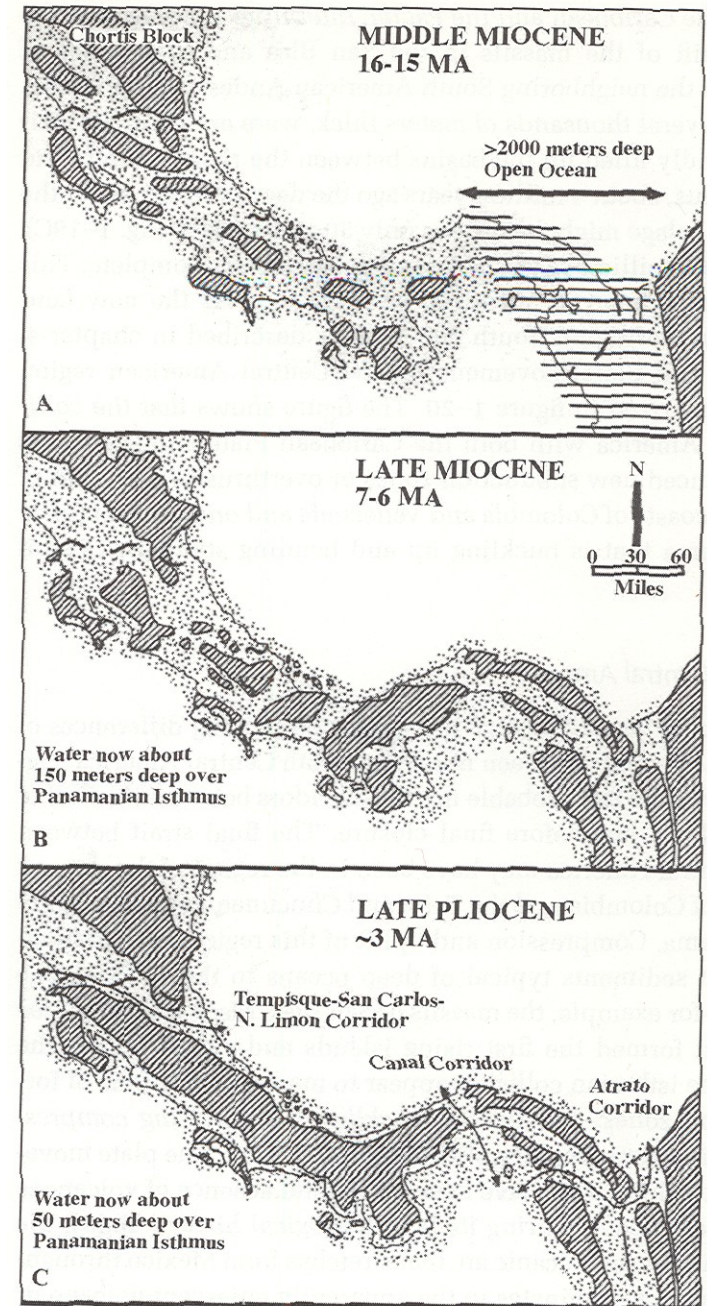


- = North and South America
- = Africa and Eurasia
- = Australasia

Barker, F. K. et al. 2004. Phylogeny and diversification of the largest avian radiation. PNAS.

Importance of isthmus established, but what was the net effect on continental biotas?

i.e.- How did it affect the distribution of New World avian diversity?



No. of Species

<u>Ancestral North</u>	Neotropical	Nearctic
• <u>Trogonidae</u>	<u>25</u>	<u>0</u>
• <u>Momotidae</u>	<u>9</u>	<u>0</u>
• Vireonidae	38	13
• Corvidae	18	17
• Polioptilidae	11	4
• Troglodytidae	66	9
• <u>Thraupidae</u>	<u>402</u>	<u>0</u>
• Parulidae	66	49
• Icteridae	76	20
• Cardinalidae	33	15
• Emberizidae	81	35

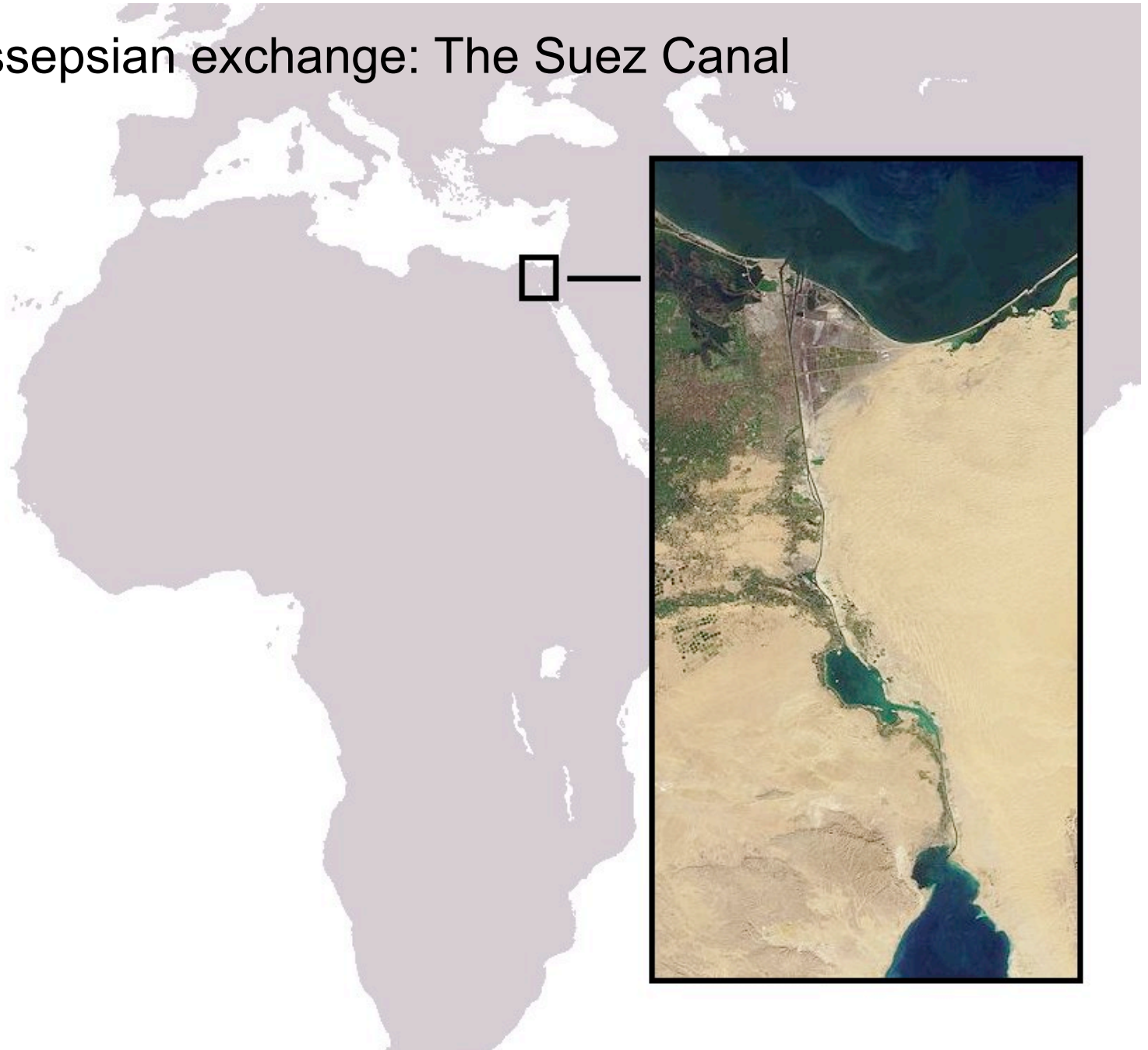


No. of Species

<u>Ancestral South</u>	Neotropical	Nearctic
• Psittacidae	150	0
• <u>Trochillidae</u>	<u>331</u>	<u>18</u>
• Ramphastidae	35	0
• Semnornithidae	2	0
• Capitonidae	11	0
• Contigidae	60	0
• Bucconidae	32	0
• Galbulidae	17	0
• Furnariidae	235	0
• Thamnophilidae	209	0
• Tityridae	31	0
• <u>Tyrannidae</u>	<u>400</u>	<u>27</u>
• Pipridae	51	0



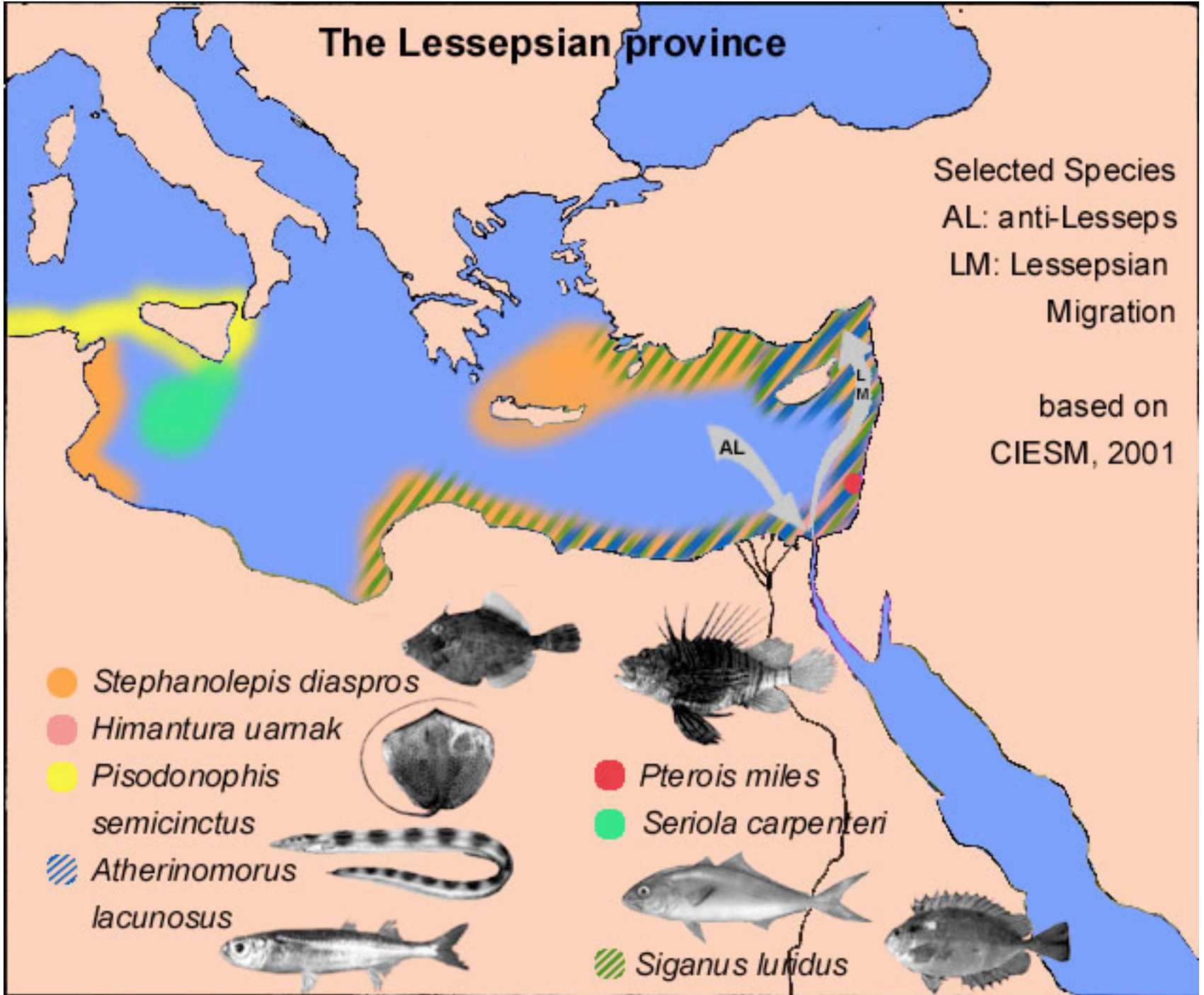
The Lessepsian exchange: The Suez Canal



The Lessepsian province

Selected Species
AL: anti-Lesseps
LM: Lessepsian
Migration

based on
CIESM, 2001



The isthmus of Panama connected the North American and South American continent, about 3.5 mya

