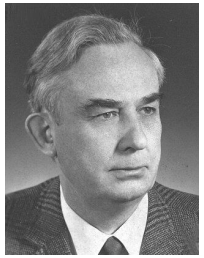
Panbiogeography

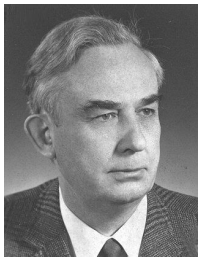
Reading: Leon Croizat

A Revolution in Biogeographical Methods

Lecture 12 Recap



Willi Hennig



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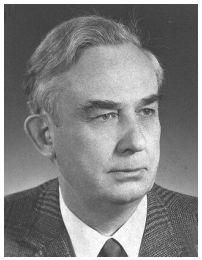
A Revolution in Biogeographical Methods

- Use traits to infer the direction of evolutionary change
- "Close relations between species and space."
- Space is not limited to *geographic* space, but also *ecological* space (phenology changes, habitat shifts)



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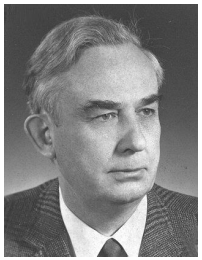
Chorological Method

1. Study a group and determine derived characters

2. Produce a phylogeny

3. Examine the phylogeny of a monophyletic group with respect to distribution of its members

4. Reexamine the phylogeny using information from the distribution and perhaps make changes in the previously determine derived characters



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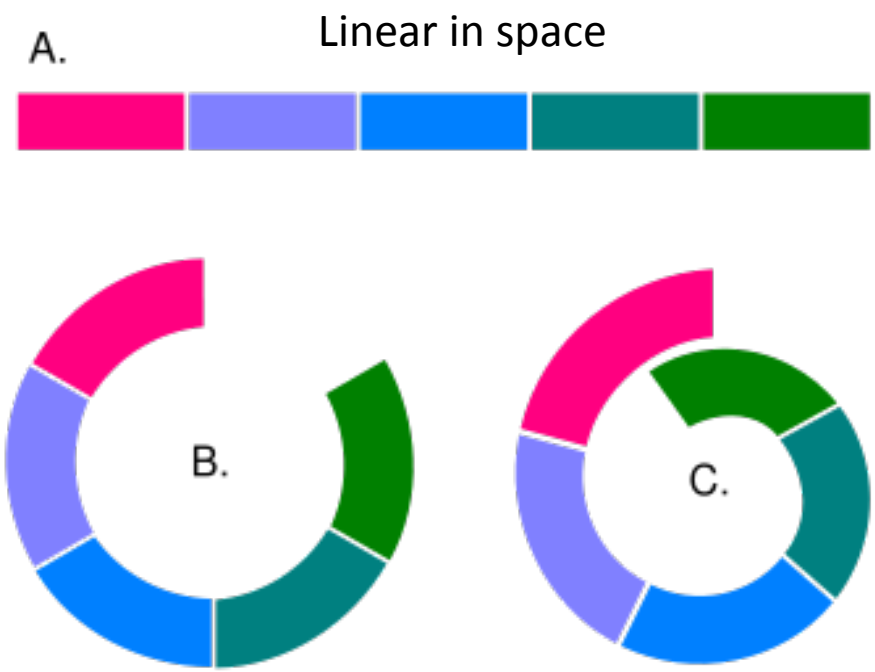
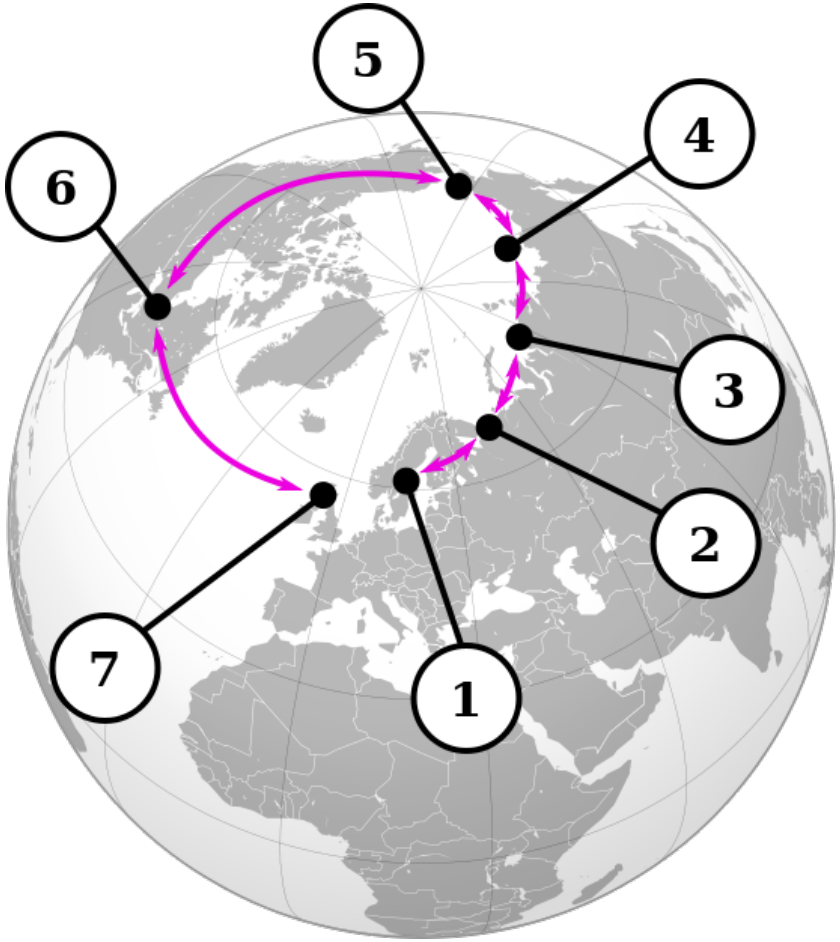


Rassenkreis
“Ring Species”

Jonathan Dwight

A Revolution in Biogeographical Methods

- *Larus* Gulls



A Revolution in Biogeographical Methods

Descriptive Biogeography → **Evolutionary Biogeography** → **Phylogenetic Biogeography**

Humboldt

Hooker

Gray

Darwin

Wallace

Hennig

Brundin

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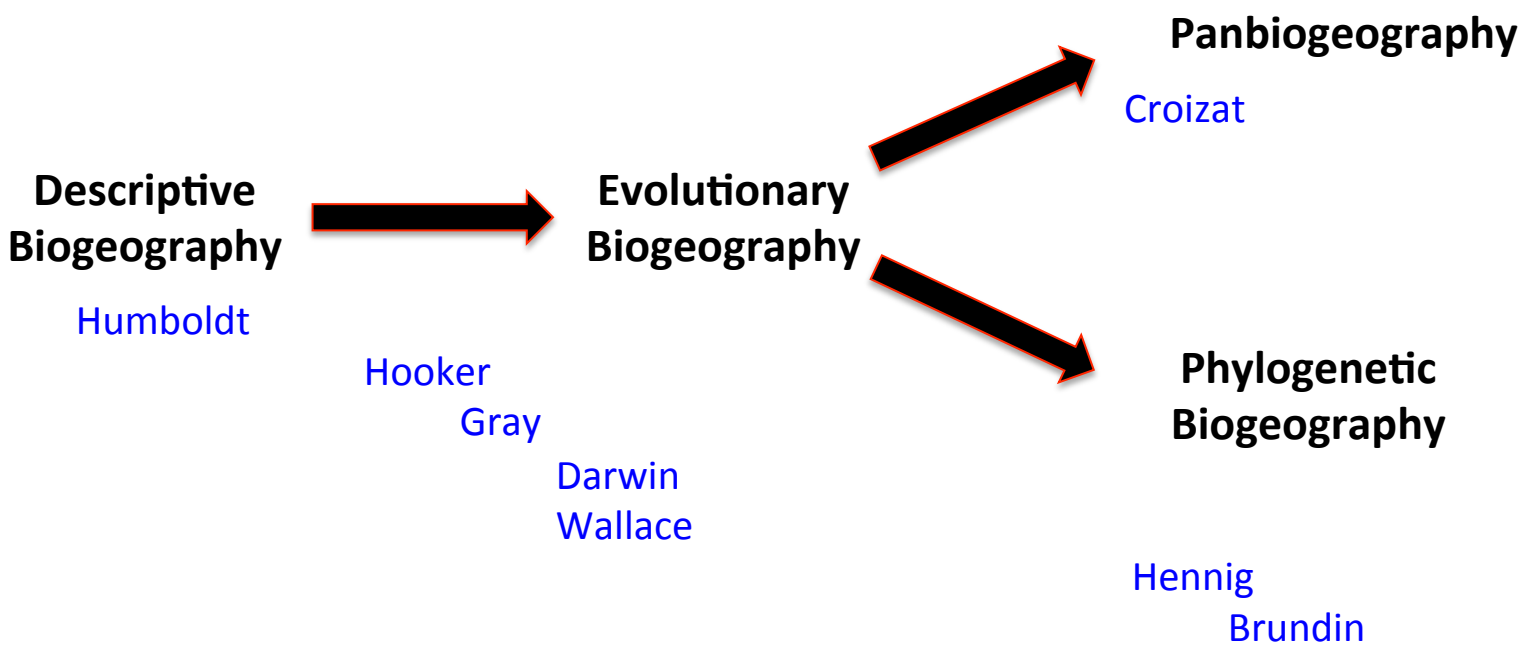
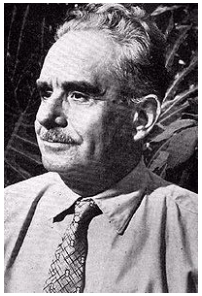


A Revolution in Biogeographical Methods

- *Panbiogeography*
- Geography and life evolved together.
- Rejects the idea of chance, long-distance dispersal events
- Incorporates many taxa simultaneously

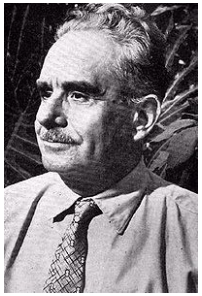

Leon Croizat

A Revolution in Biogeographical Methods

- Born in Italy in 1894

- Graduate of law school, but emigrated to New York to pursue art (30 years old)

- Due to economic crash, began to ID plants for New York Public Parks and became friends with the director of Bronx Botanical Gardens, and was hired as a technical assistant when the director moved to Harvard (43 years old)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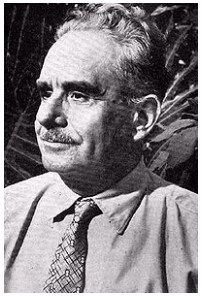
- Pursued academic study and became vehemently opposed to Darwin's view of long distance dispersal (LDD) of organisms
- Saw LDD as an easy way out of explaining complex distributions (so did Darwin, good overview article posted online)
- Offered a position at the Central University of Venezuela (53 years old)
- Began a period of prolific writing in the early 1950's to 1960's, outlining his idea called *Panbiogeography*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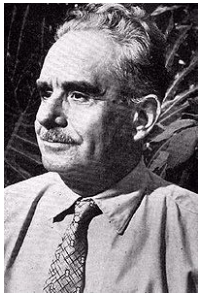
- *Space, Time, Form: The Biological Synthesis*
- *"…biogeographers… students of the effects of space and time on the course of organic evolution."*
- *"… answer our own needs, our own methods, our own aims as biogeographers."*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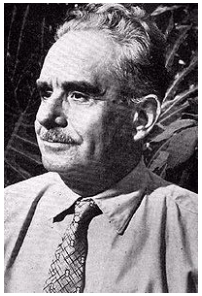
A Revolution in Biogeographical Methods

- *Panbiogeography*
- Based on the idea that life and the earth are evolving simultaneously
- Heavy influence of continental vicariance (*ultra-vicariance*) over dispersal

Alan de Queiroz

A Revolution in Biogeographical Methods

"Croizat had a grand vision, a unified theory of the geography of life. It boiled down to this: the distributions of groups, from orchids to earthworms to armadillos, all reflected the dynamic climatic and geologic history of the planet itself. Sea levels rose to inundate land bridges; ocean basins opened, dividing continents; island arcs plowed into continental margins. These changes in the configurations of landmasses and oceans left an indelible imprint on life. In fact, that imprint was so unmistakable that one could use the distributions of living things to reveal the history of the Earth." - The Monkey's Voyage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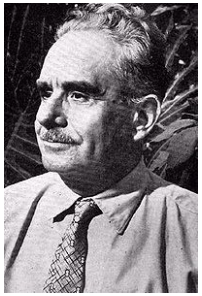
- *The Panbiogeographical Method*

1. Map the ranges of the species of a given group

2. Connect the ranges with a line to form a track, these would be minimum line, connecting all localities with the shortest possible path

3. Do this over and over again for different taxa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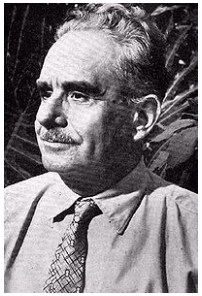
- *The Panbiogeographical Method*

4. If tracks follow the same routes, they form a generalized track

5. These generalized tracks are an empirical phenomenon

6. Unite continental areas that together are an estimate of the distribution of an ancestral biota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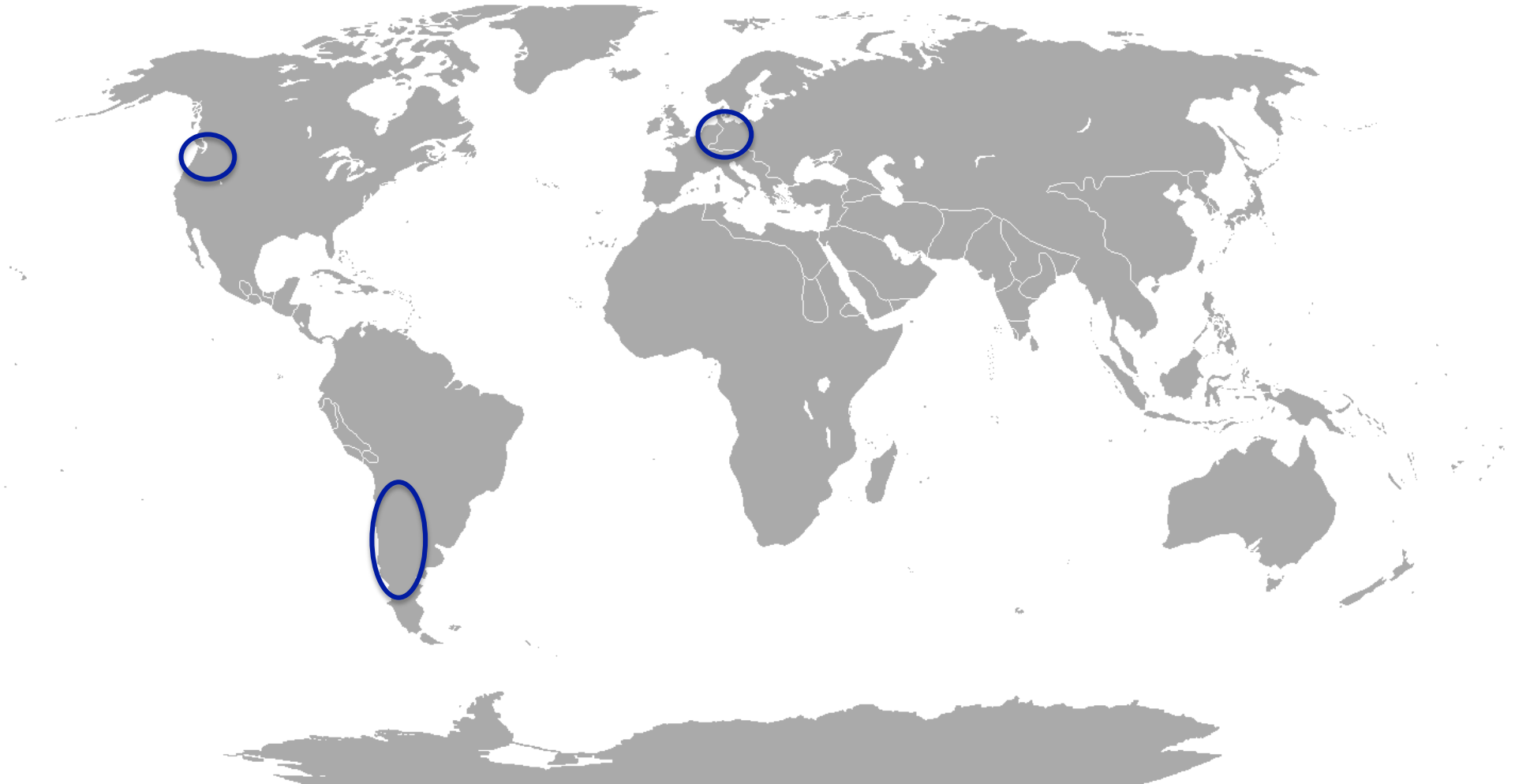

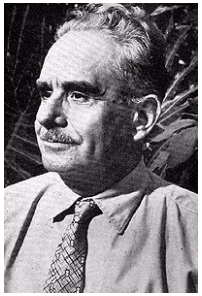
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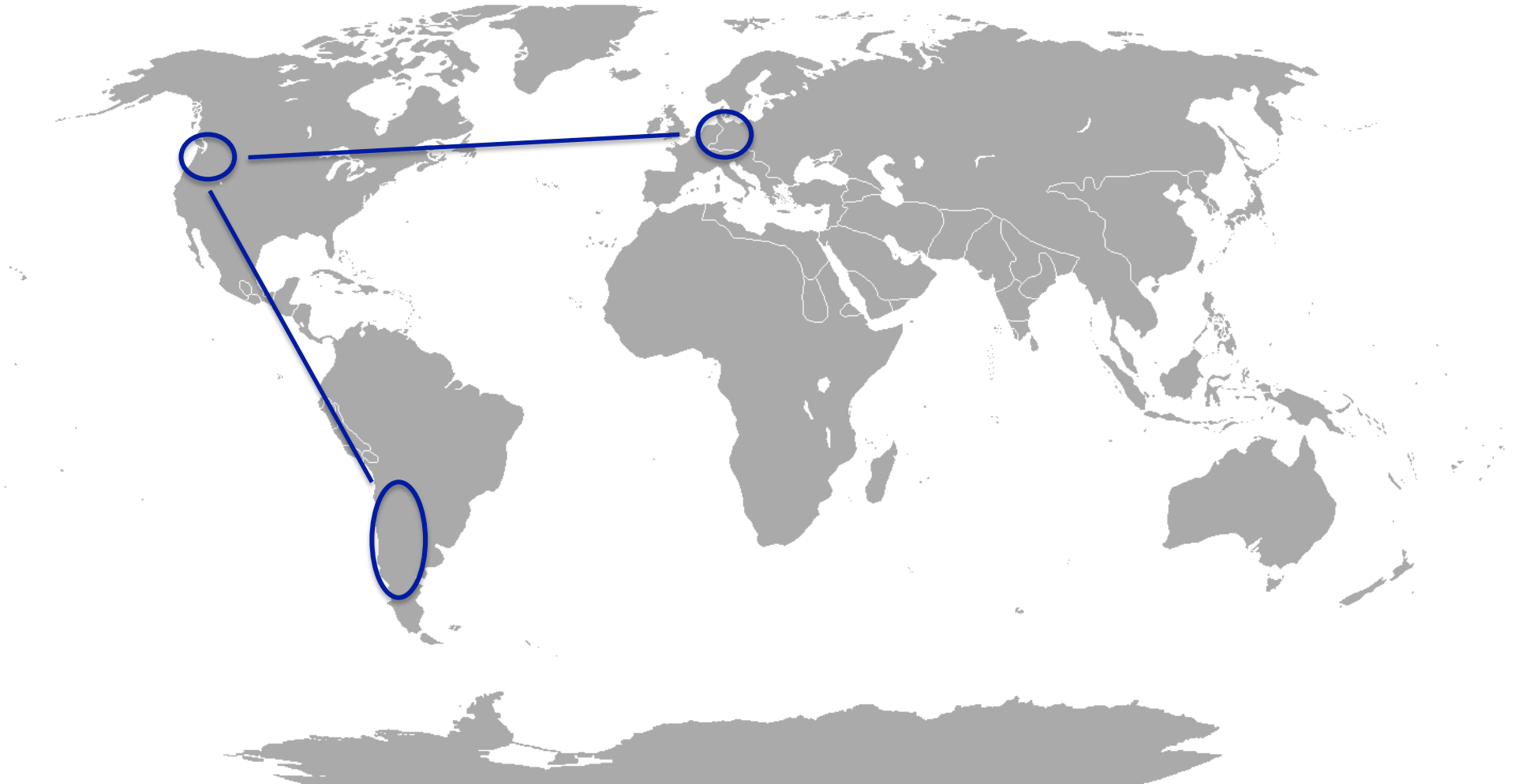

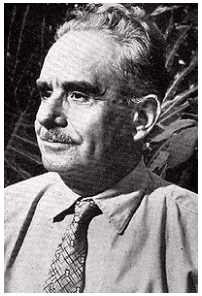
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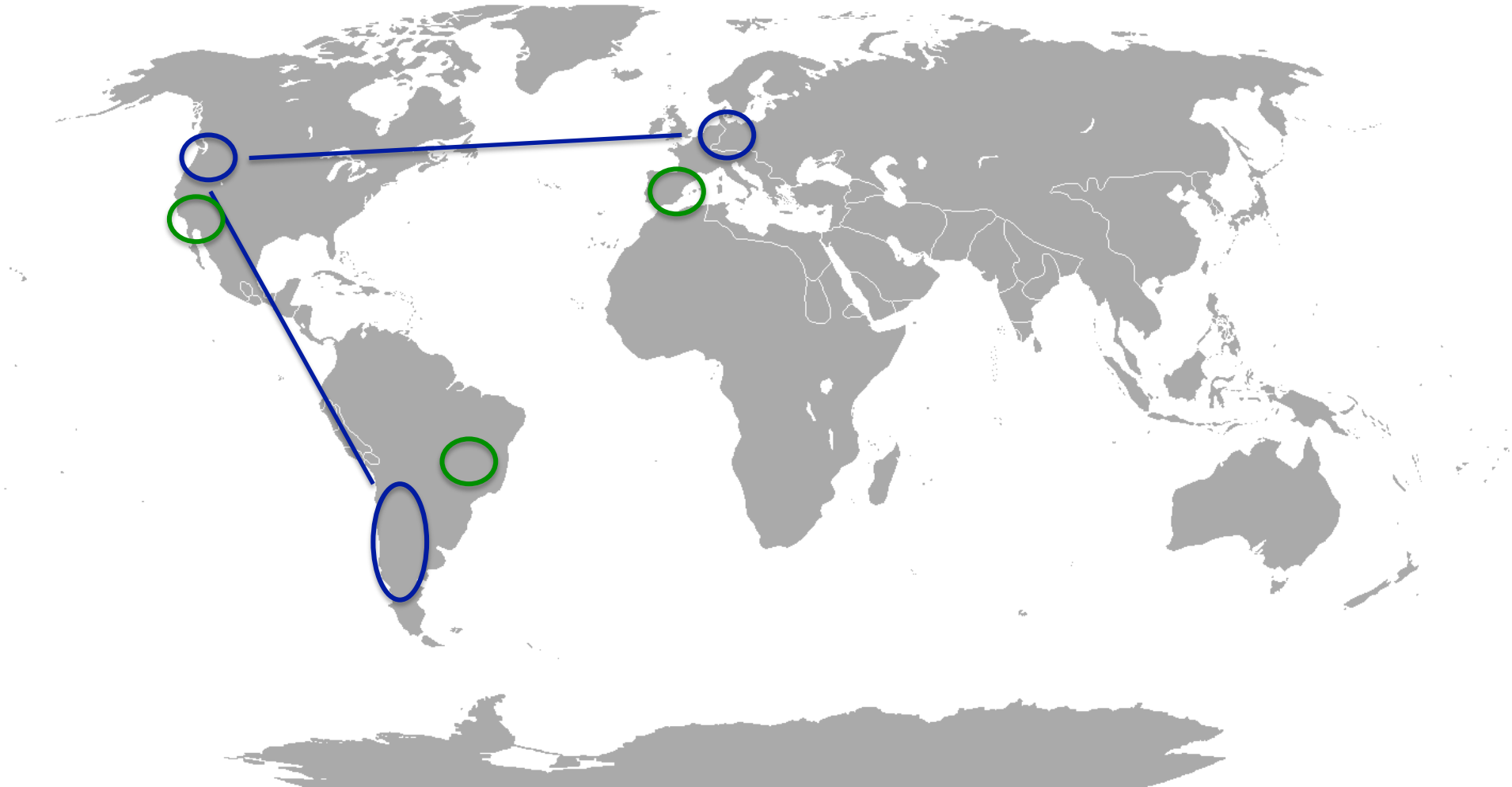

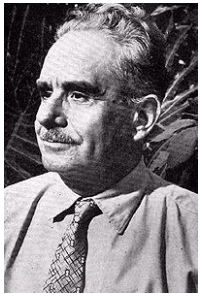
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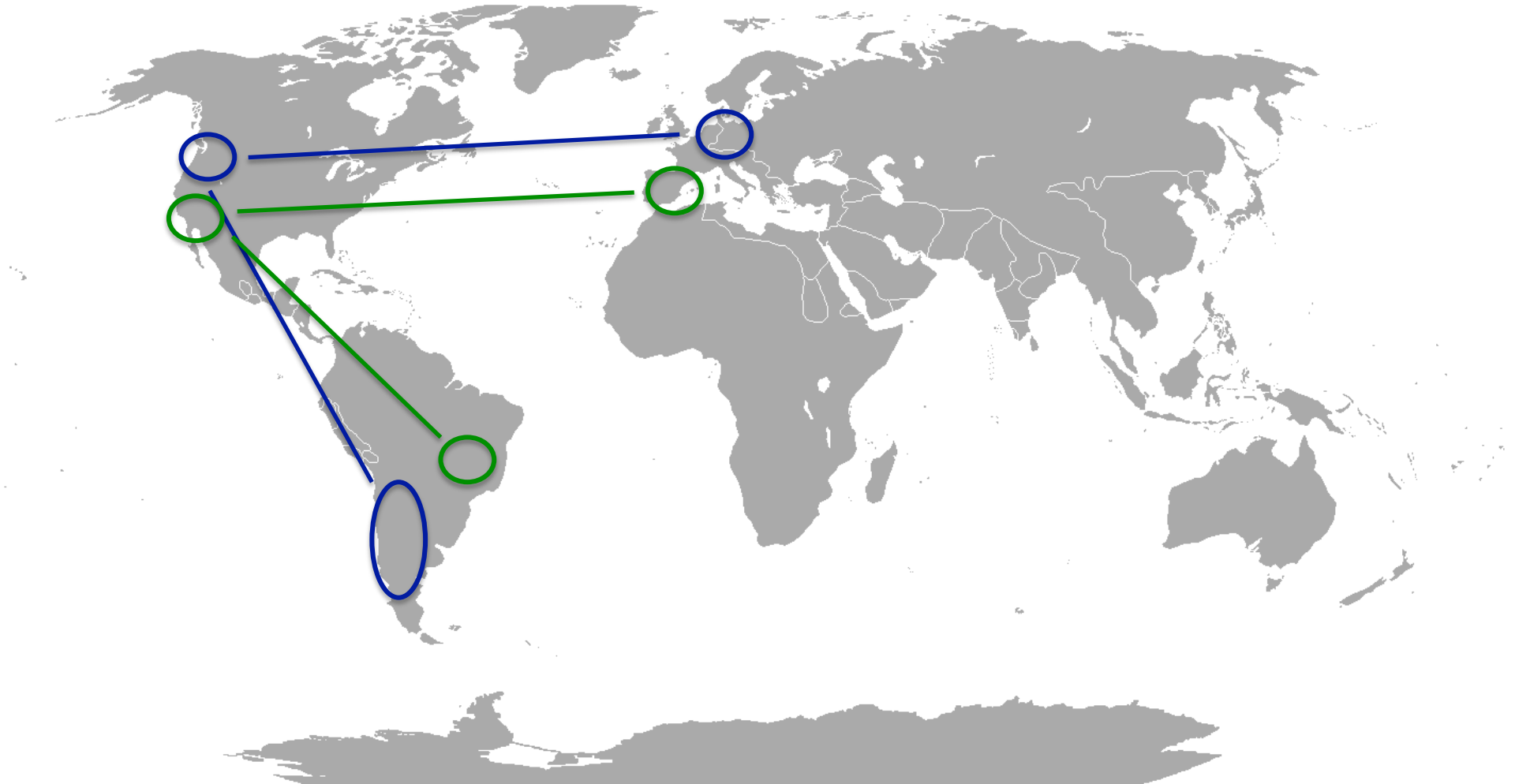

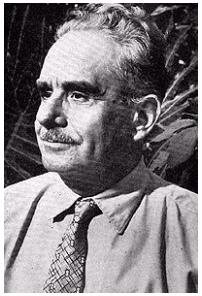
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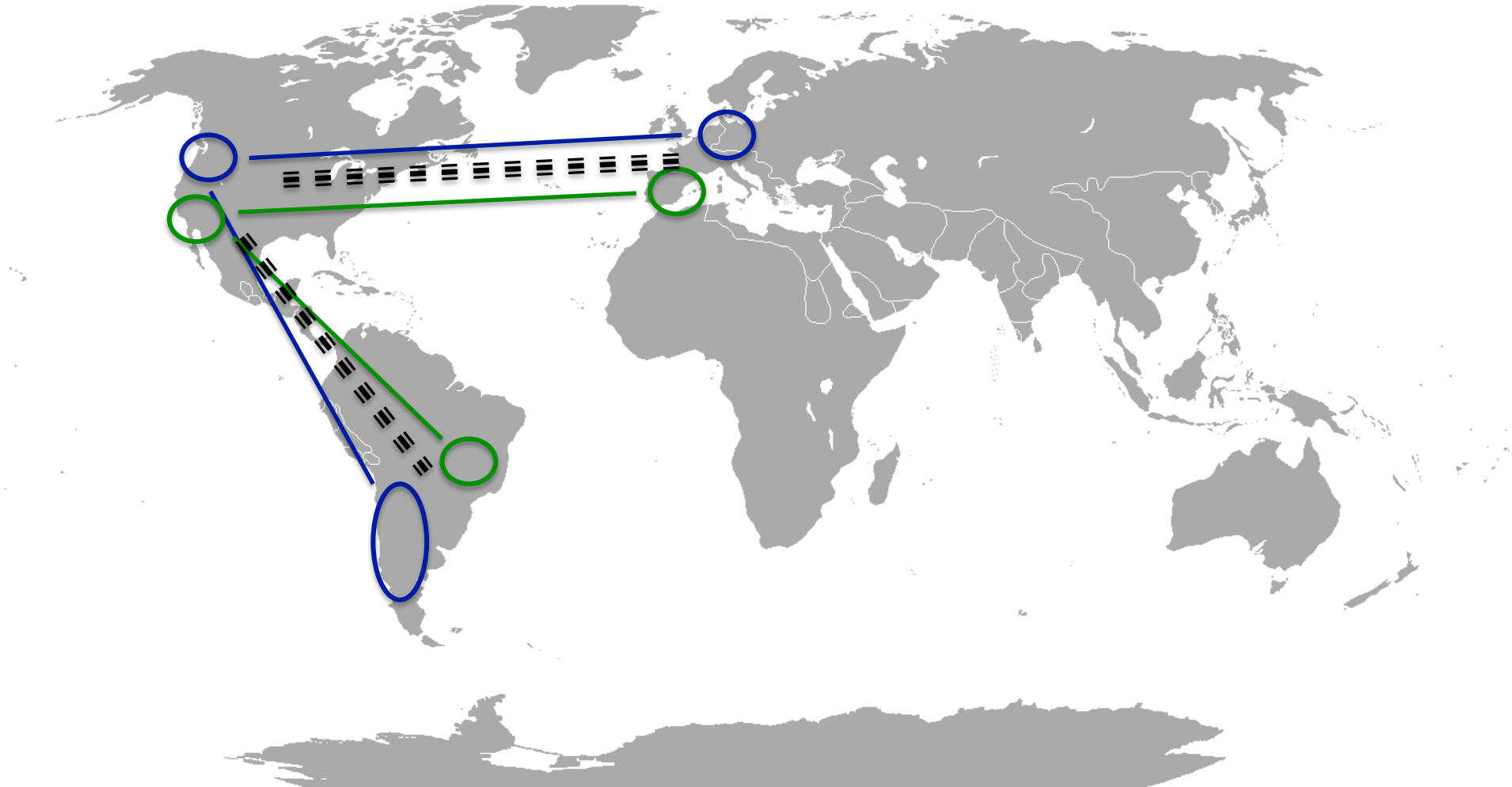

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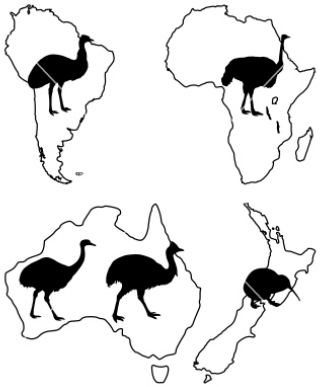
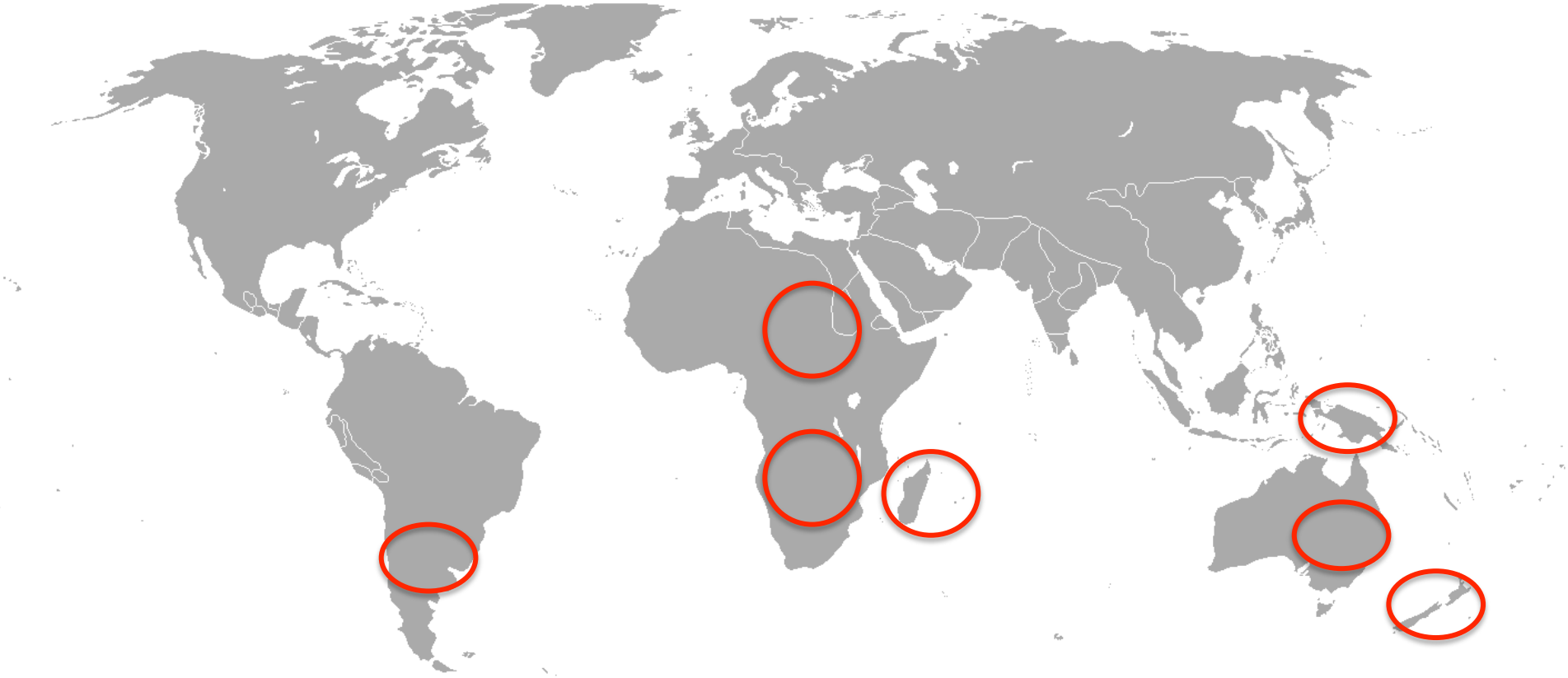


- *Issues with Panbiogeography – Ratite Distribution*



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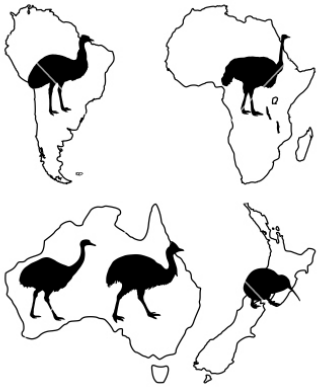
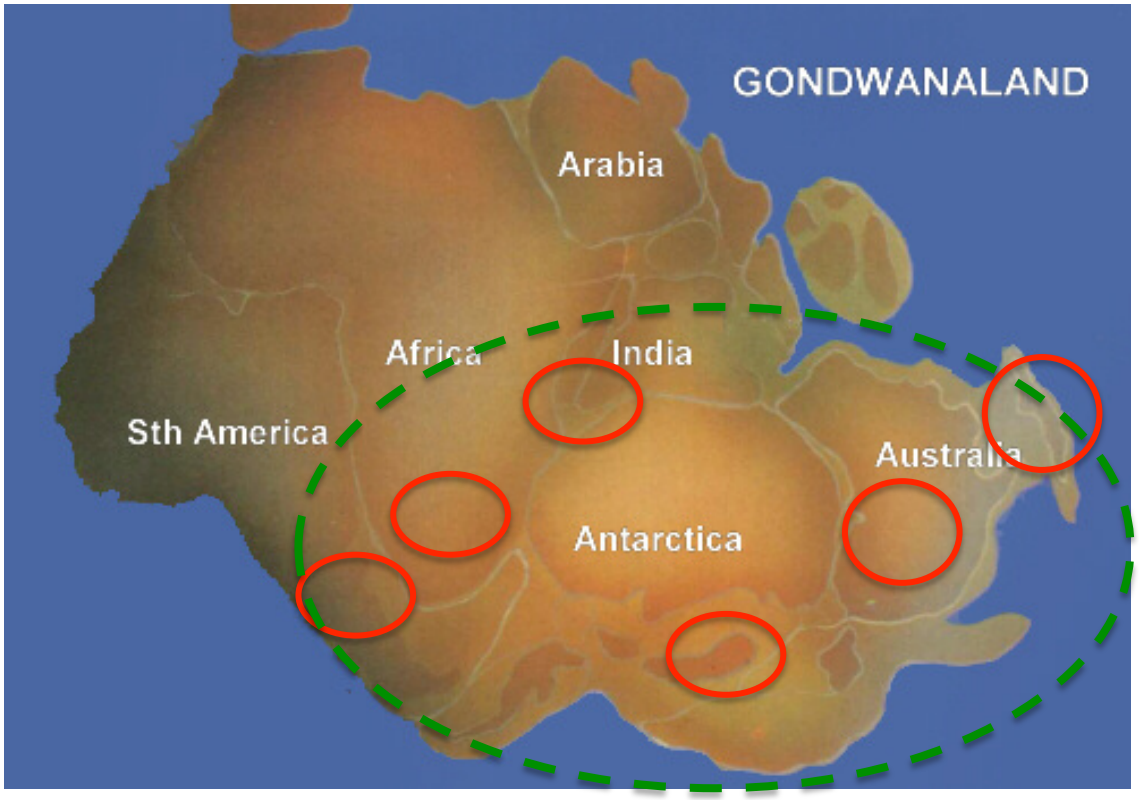


- *Could be ancient vicariance*



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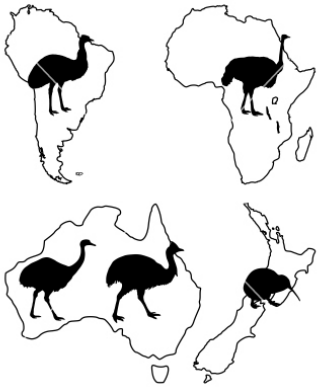

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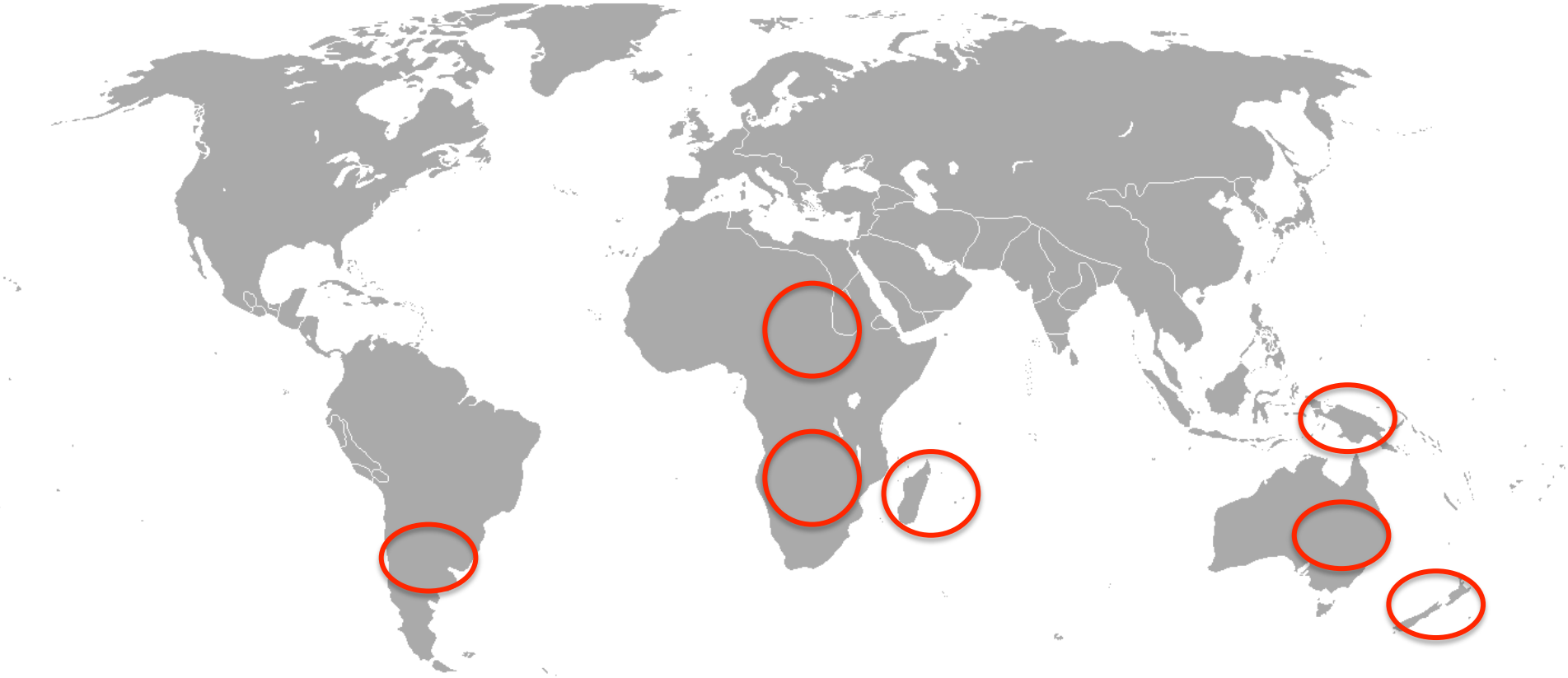

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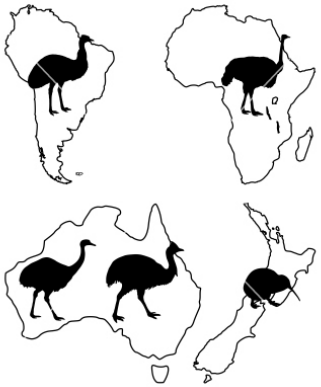

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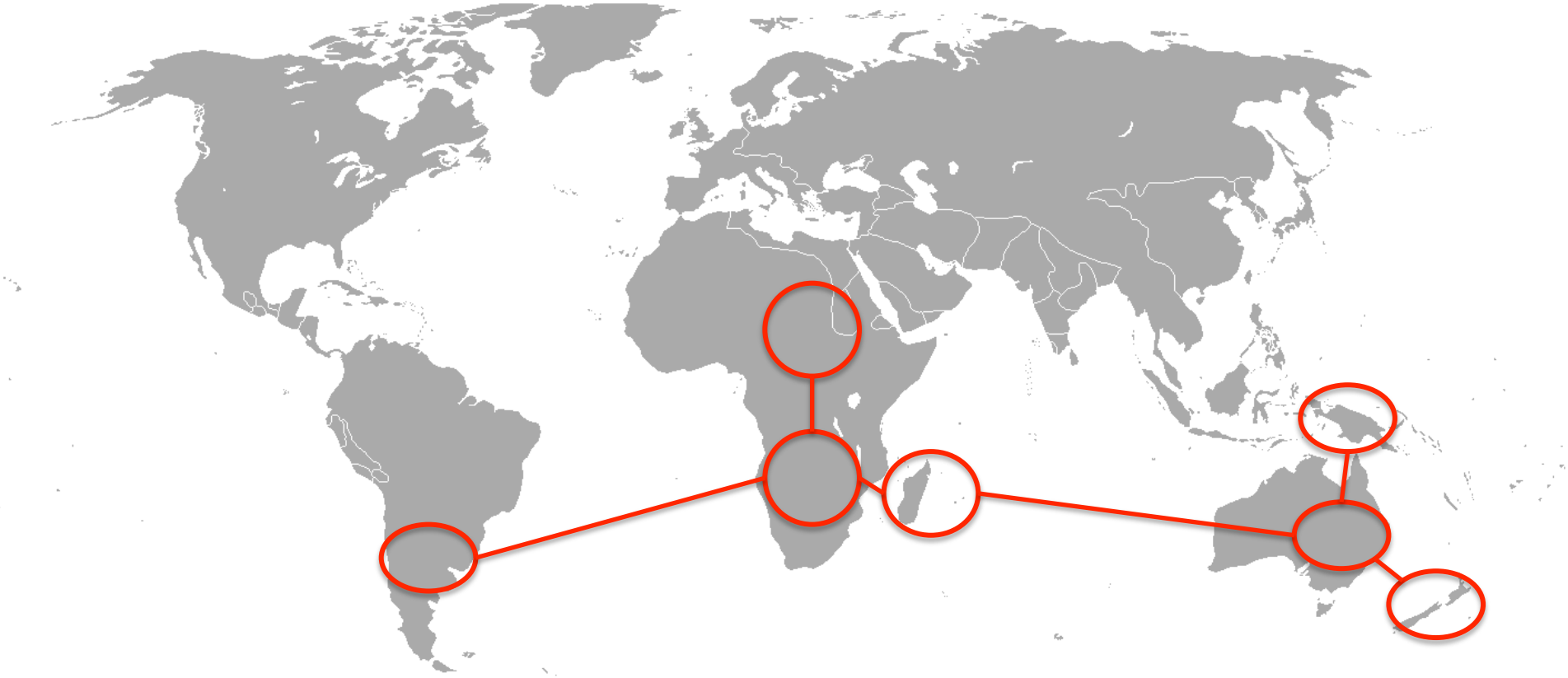

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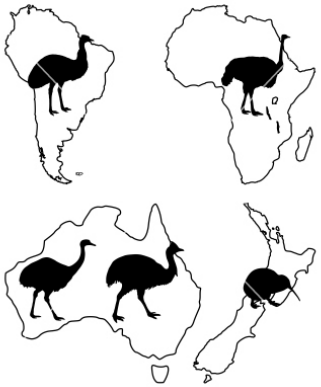
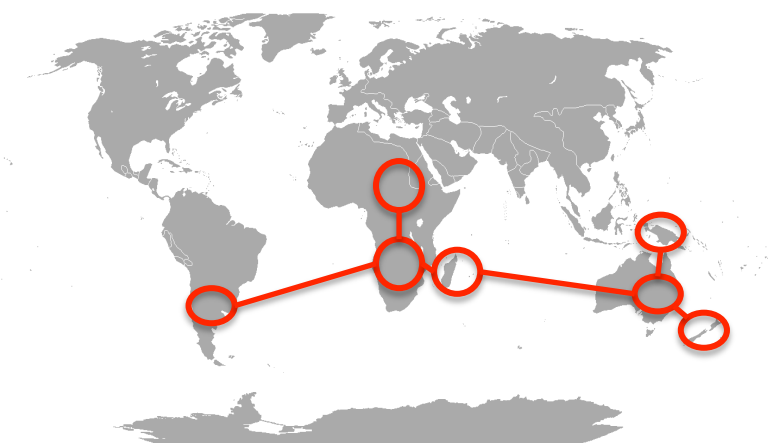
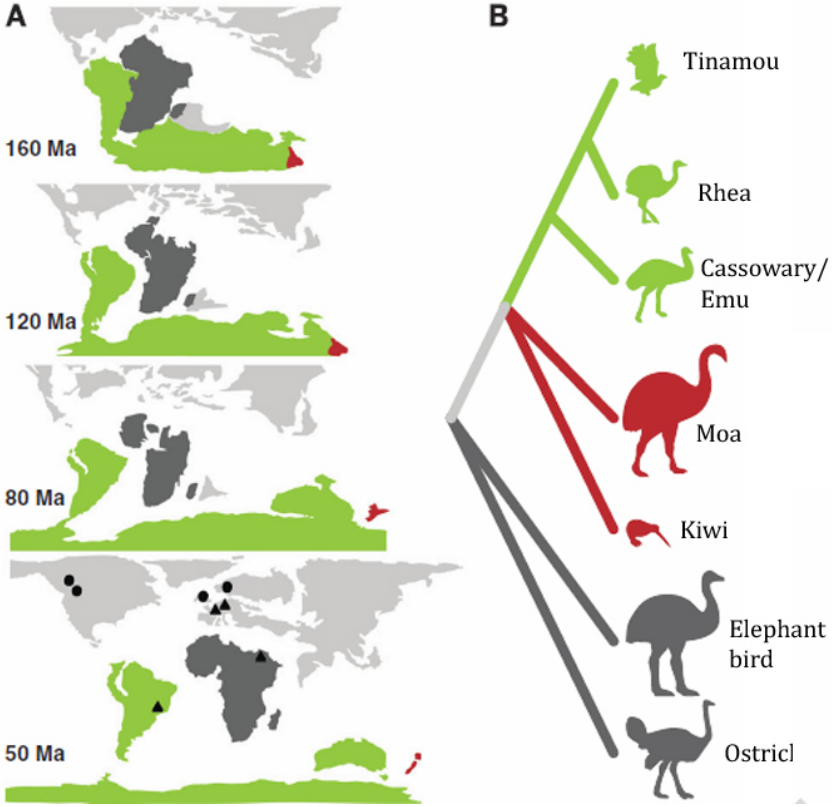


- *Phylogeny based on panbiogeography*





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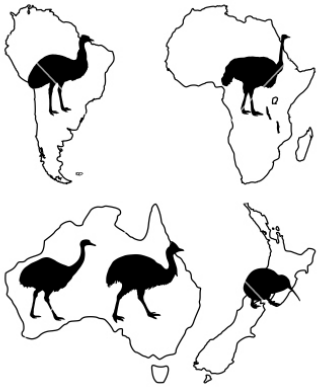
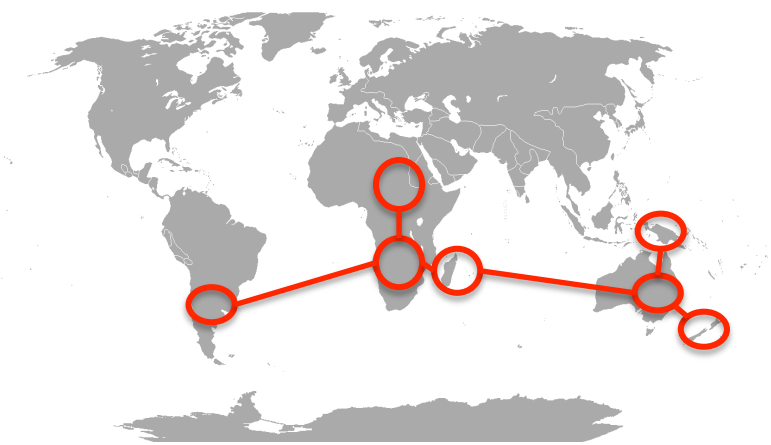
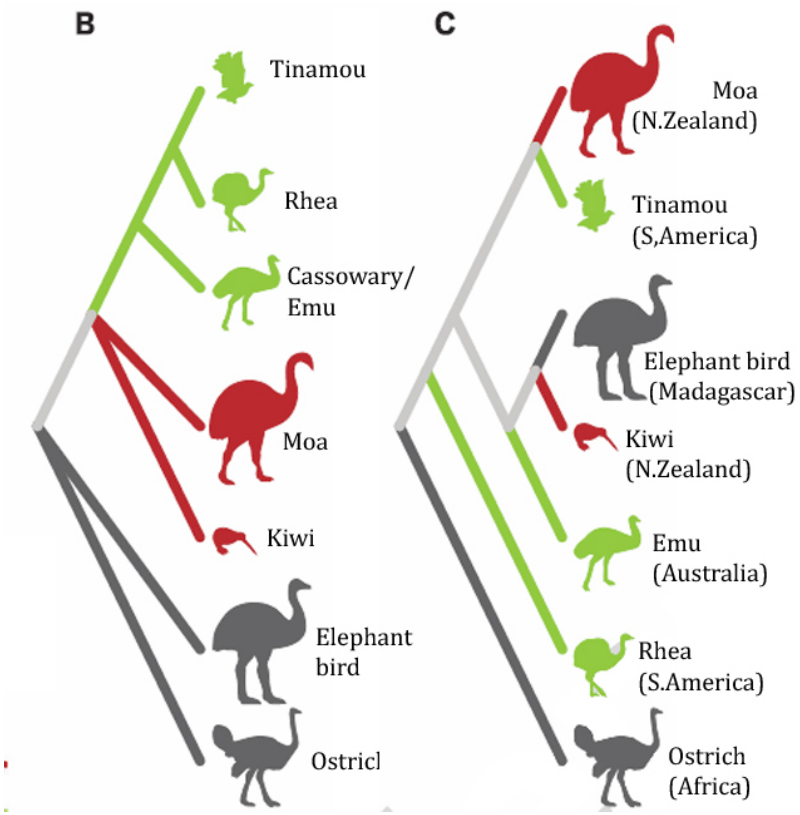


- *Phylogeny based on panbiogeography* *Actual phylogeny*





Alan Cooper

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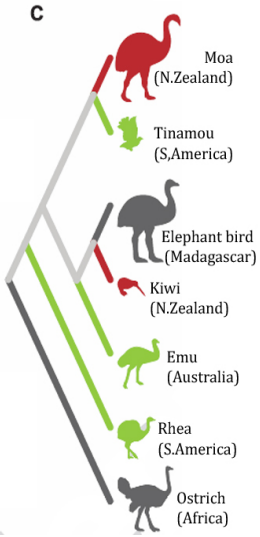
Alan Cooper



- *What is going on then?*
- *Geographic neighbors aren't necessarily evolutionary neighbors*
- NZ Kiwi's are more closely related to Australian emus and cassowaries than their (recently extinct) island neighbor the moa
- In fact, not all *Ratites* are flightless, and the South American tinamou is the closest relative to the moa

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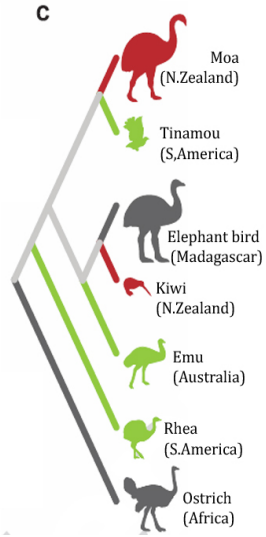

- *What is going on then?*
- *There is only one possible explanation*

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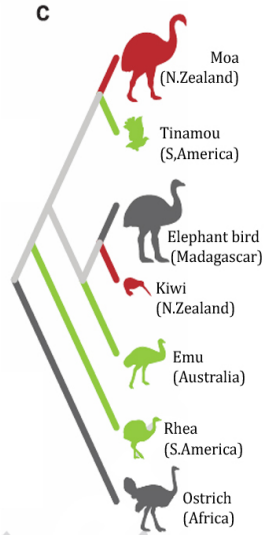

- *What is going on then?*
- *There is only one possible explanation*
- The *Ratites* all evolved from small flying birds and independently lost the ability to fly on at least *six separate occasions*
- An incredible example of convergent evolution

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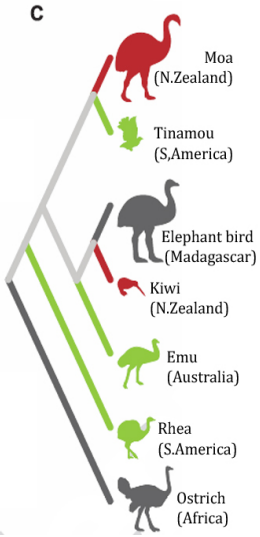

- The idea is that the ratites developed shortly after the extinction of the dinosaurs (~65 mya)
- There were were many plants and not many predators, so there was an ecological vacuum, and they evolved into big plant eaters
- After 10 million years, mammals began to do the same thing, they were too big gain flight back, so they "ran like hell" unless you are a kiwi in NZ where the island where big predators never developed

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- *The point is that you can end up with the same patterns using vicariance or dispersal*

- *It is the timing of these patterns that matter*

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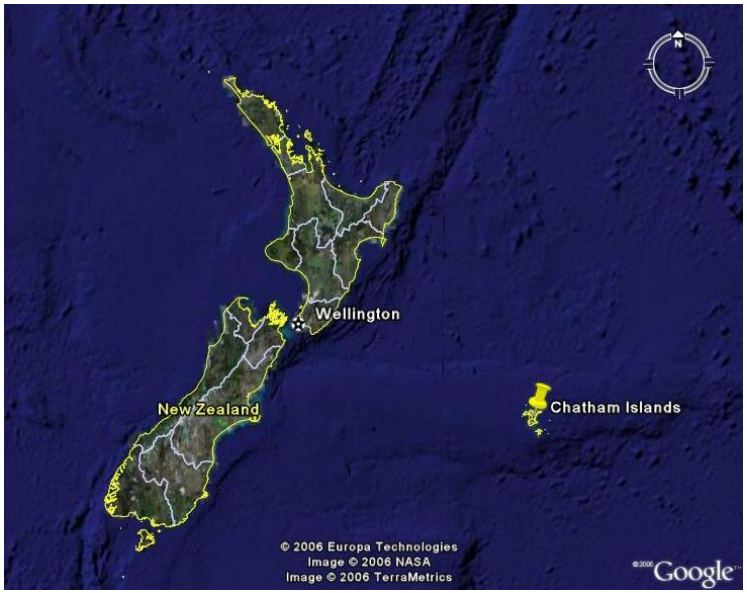
- *Example using geology: Chatham Islands, NZ*



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- *Example using geology: Chatham Islands, NZ*
- 800 km from NZ
- Current islands are only about 3-4 million years old
- So the biota had to have arrived by LDD

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- *Example using geology: Chatham Islands, NZ*
- Examined dune fauna around mainland NZ
- 580 taxa on NZ, 183 on Chatham (1/3 the size of the mainland)
- Molecular data consistent that taxa diverged a few million years at most
- A large number of taxa can colonize across a large water gap

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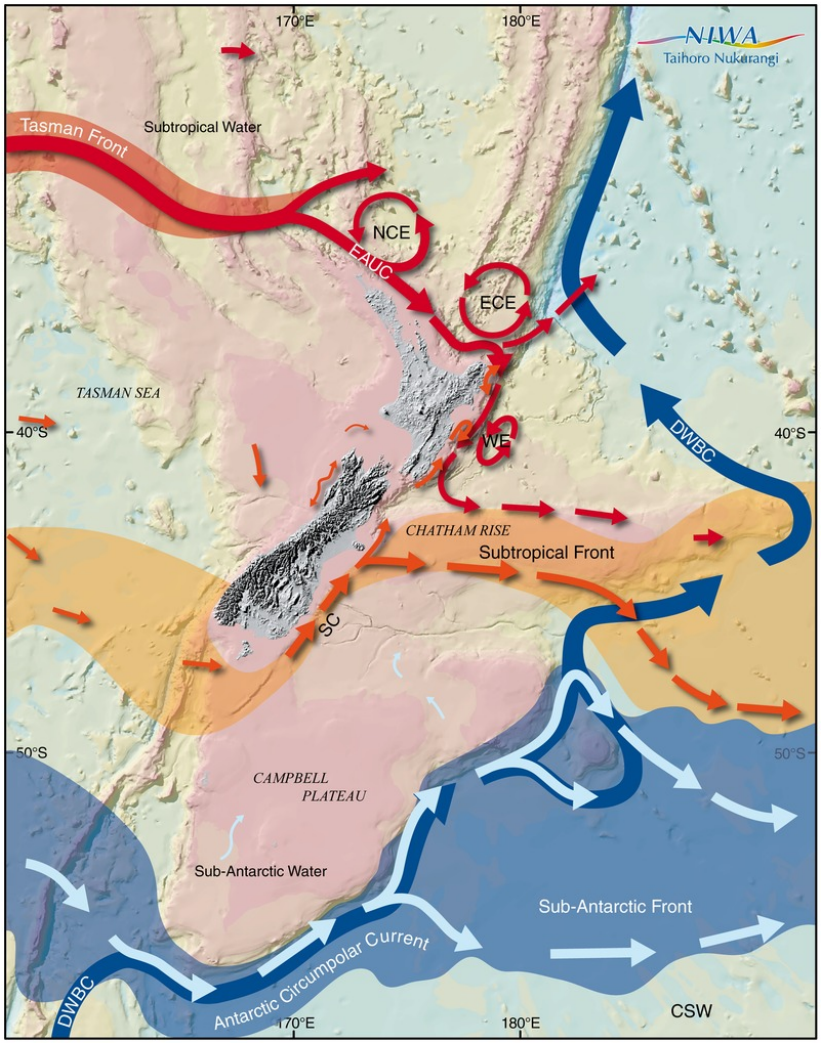

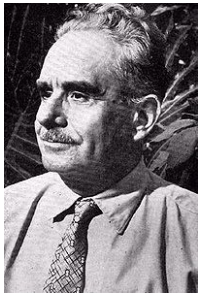
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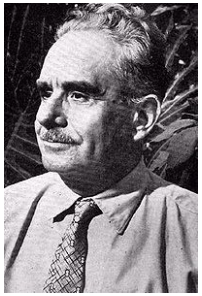
Main Points

- *Panbiogeography* - geography and life evolved together
- Heavy influence of continental vicariance over dispersal
- There are examples where panbiogeography does not work (*Ratites*)
- Many taxa are capable of LDD in situations were there continental vicariance is surely not the case

Questions on the reading?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Discussion Point

- Croizat questioned all biogeographical methods and rejected dogma.

- When should we question published results? Do you think that Croizat makes some good points in the reading?

- What is the trade-off between questioning results and building off of them?