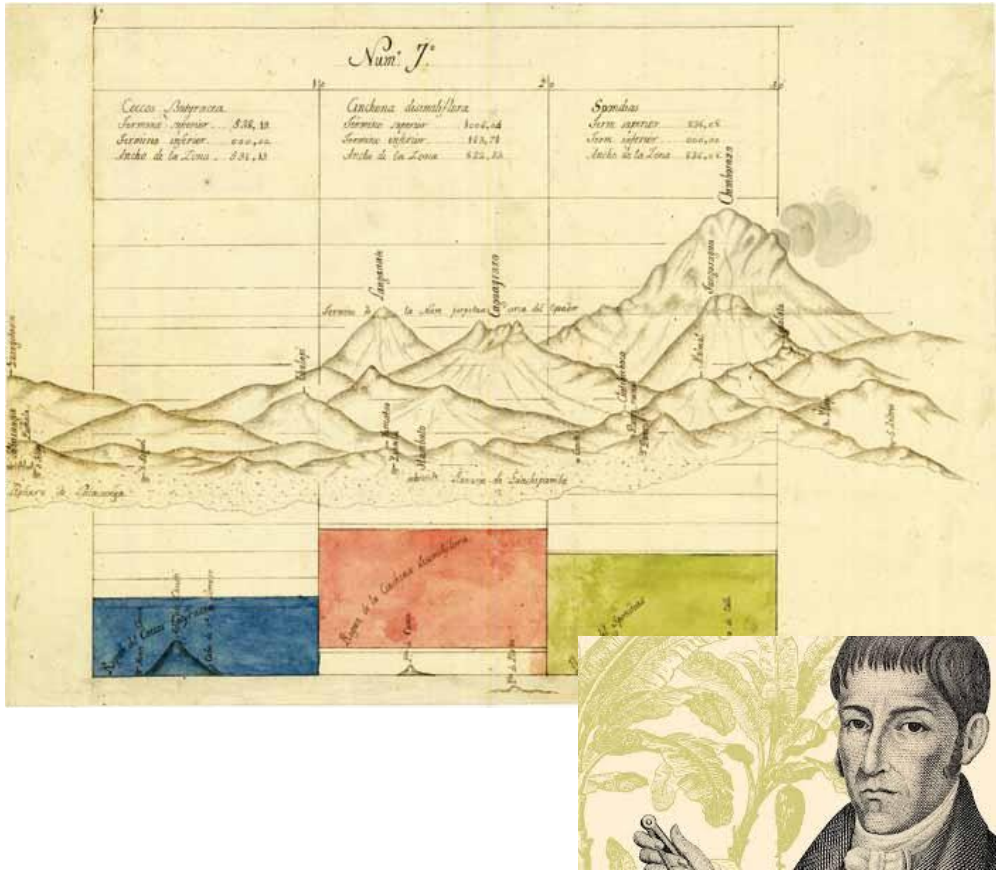
Taller Métodos Comparativos para Naturalistas

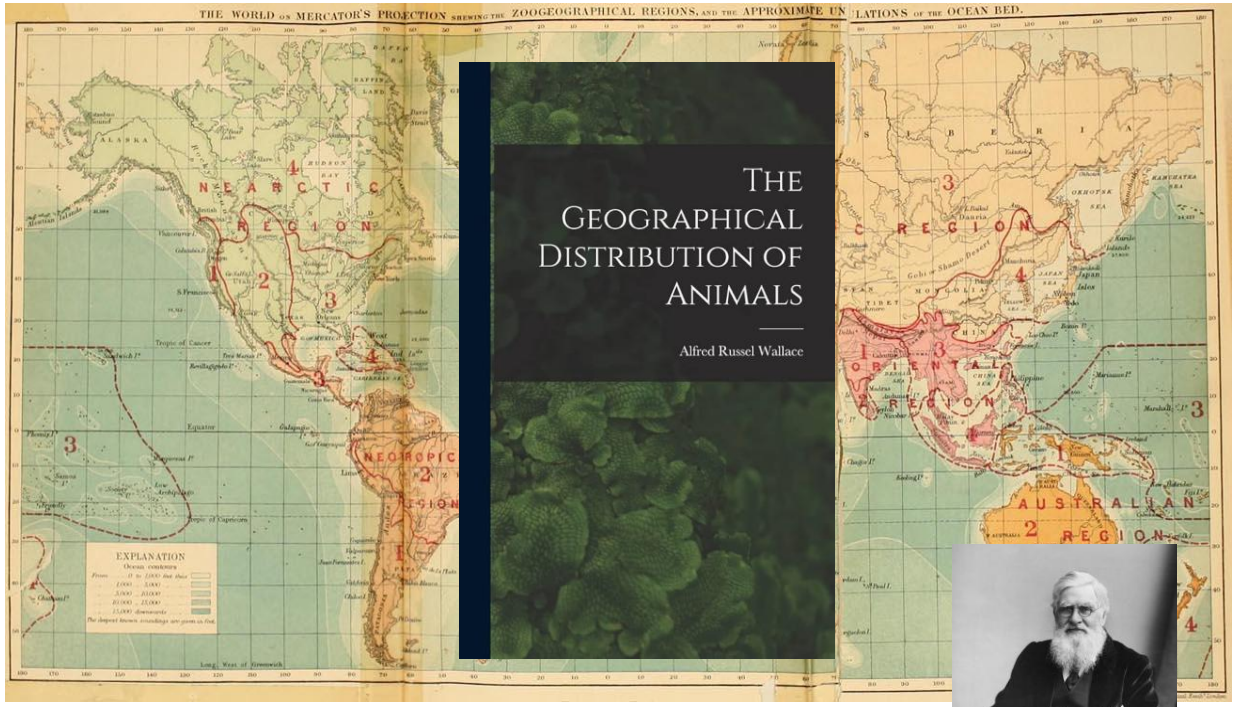
Introducción a Modelos Biogeográficos

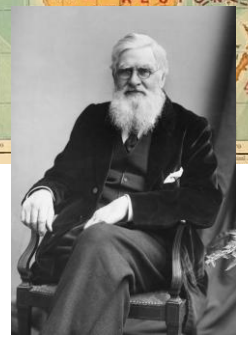
PUCE, Quito

La evolución y distribución de organismos esta vinculada a la historia de los lugares donde se encuentran

De la historia natural a los modelos biogeográficos



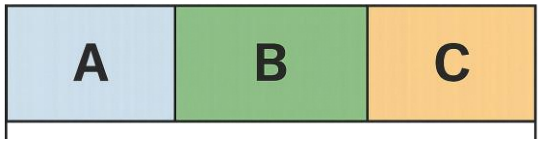




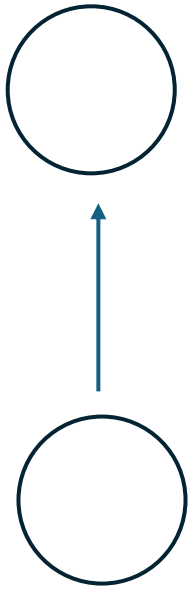
¿Cómo eventos de dispersión, especiación y extinción generan patrones biogeográficos?

Dispersión–Extinción–Cladogénesis (DEC)

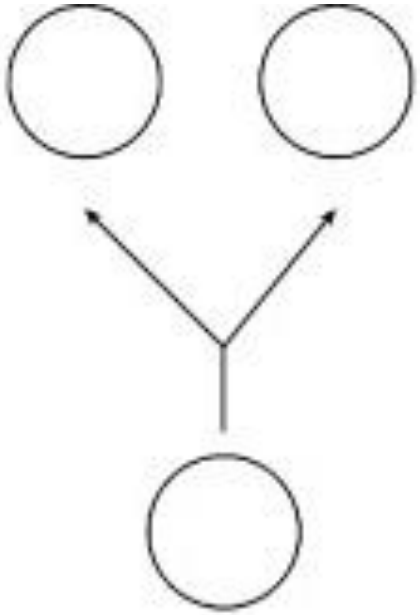
Rango



Anagenesis



Cladogenesis



Modelo DEC: Rango

- Áreas como caracteres discretos

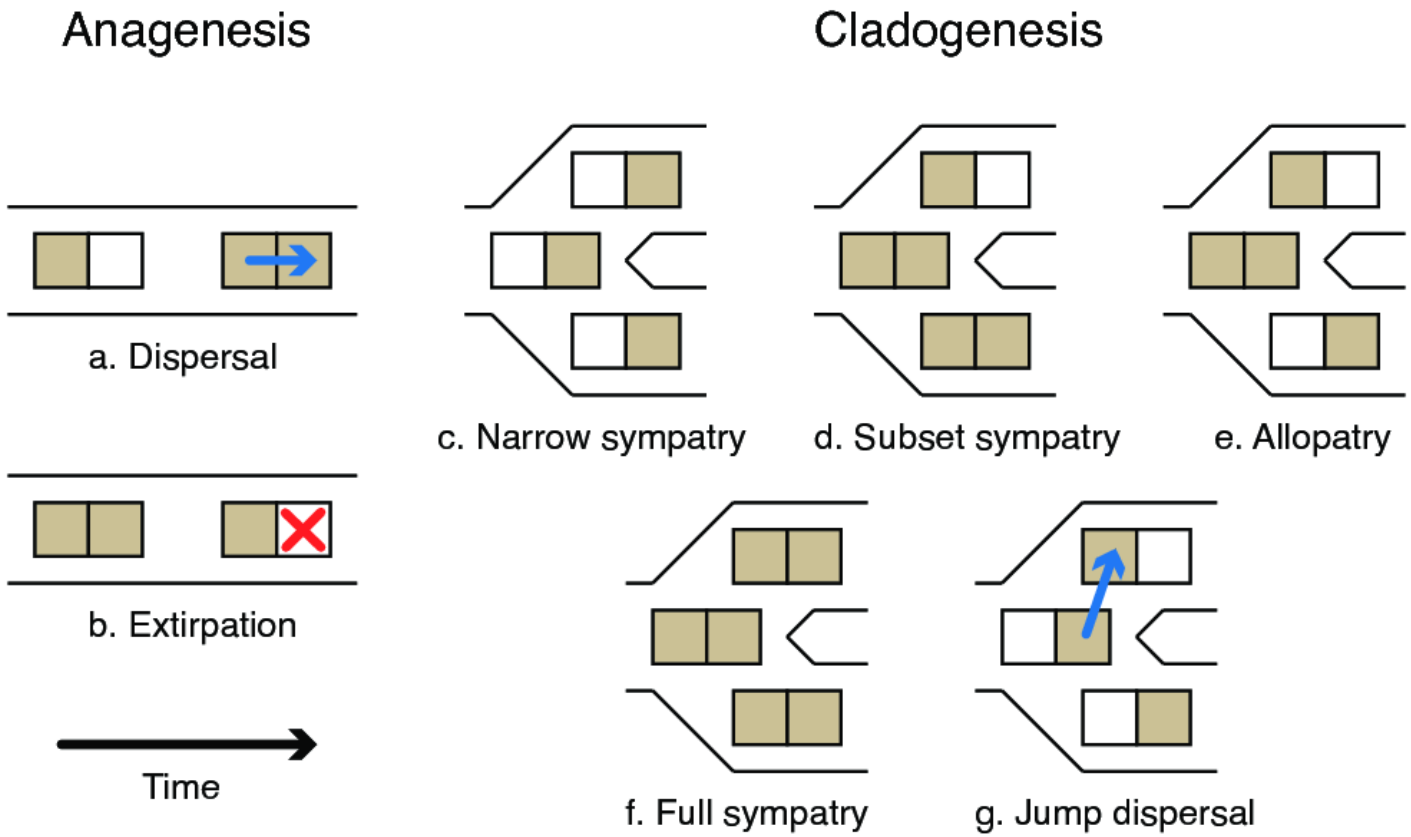
A, B, C

- Rango: presencia/ausencia

AC = 101

Range	Bits	Size	Integer
∅	000	0	0
A	100	1	1
B	010	1	2
C	001	1	3
AB	110	2	4
AC	101	2	5
BC	011	2	6
ABC	111	3	7

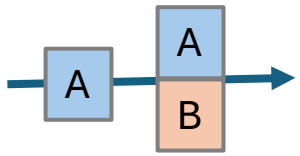
¿Cómo cambia el rango en el tiempo?



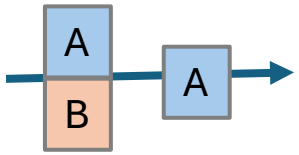
Evolución anagenética del rango

Cambios a lo largo de las ramas

d = dispersión
e = extinción/ extirpación



Dispersión



Extinción/Extirpación

La matriz *Q*

$$\mathbf{Q} = \begin{array}{c|cccccccc} & \emptyset & A & B & C & AB & AC & BC & ABC \\ \hline \emptyset & - & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A & e_A & - & 0 & 0 & d_{AB} & d_{AC} & 0 & 0 \\ B & e_B & 0 & - & 0 & d_{BA} & 0 & d_{BC} & 0 \\ C & e_C & 0 & 0 & - & 0 & d_{CA} & d_{CB} & 0 \\ AB & 0 & e_B & e_A & 0 & - & 0 & 0 & d_{AC} + d_{BC} \\ AC & 0 & e_C & 0 & e_A & 0 & - & 0 & d_{AB} + d_{CB} \\ BC & 0 & 0 & e_C & e_B & 0 & 0 & - & d_{BA} + d_{CA} \\ ABC & 0 & 0 & 0 & 0 & e_C & e_B & e_A & - \end{array}$$

La matriz *Q*

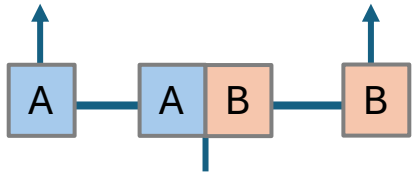
- No puedes ganar o perder más de un área a la vez
- No hay cambios simultáneos complejos

d = dispersión
e = extirpación

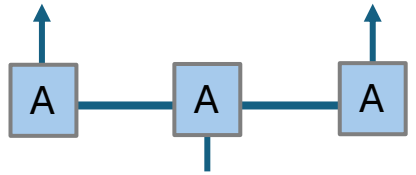
$$\mathbf{Q} = \begin{array}{c|cccccccc} & \emptyset & A & B & C & AB & AC & BC & ABC \\ \hline \emptyset & - & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A & e_A & - & 0 & 0 & d_{AB} & d_{AC} & 0 & 0 \\ B & e_B & 0 & - & 0 & d_{BA} & 0 & d_{BC} & 0 \\ C & e_C & 0 & 0 & - & 0 & d_{CA} & d_{CB} & 0 \\ AB & 0 & e_B & e_A & 0 & - & 0 & 0 & d_{AC} + d_{BC} \\ AC & 0 & e_C & 0 & e_A & 0 & - & 0 & d_{AB} + d_{CB} \\ BC & 0 & 0 & e_C & e_B & 0 & 0 & - & d_{BA} + d_{CA} \\ ABC & 0 & 0 & 0 & 0 & e_C & e_B & e_A & - \end{array}$$

$$\mathbf{P}_{ij}(t) = \left[\exp\left\{\mathbf{Q}t\right\}\right]_{ij}$$

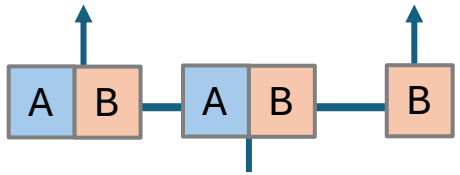
Evolución cladogenética del rango



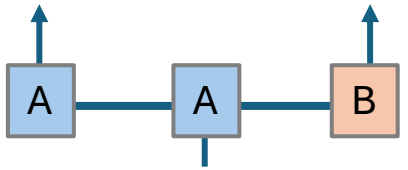
Alopatría



Simpatría



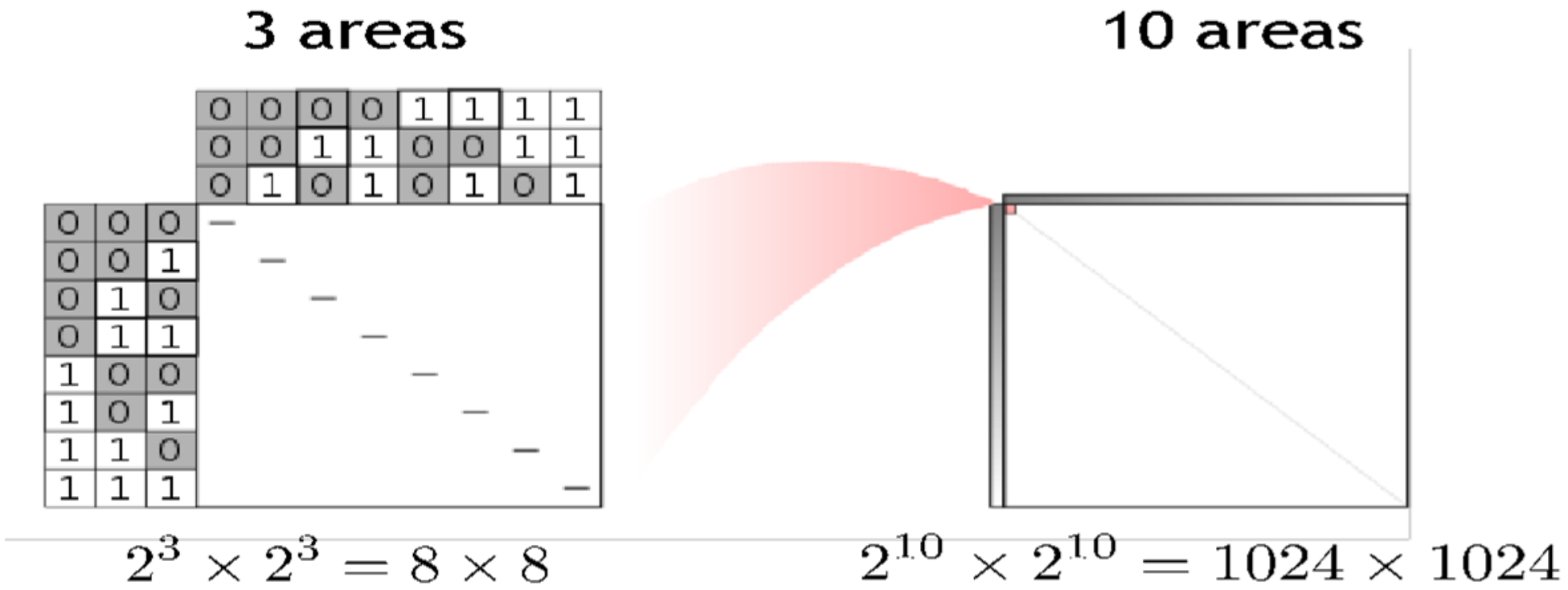
Simpatría de subconjunto



Dispersión por salto

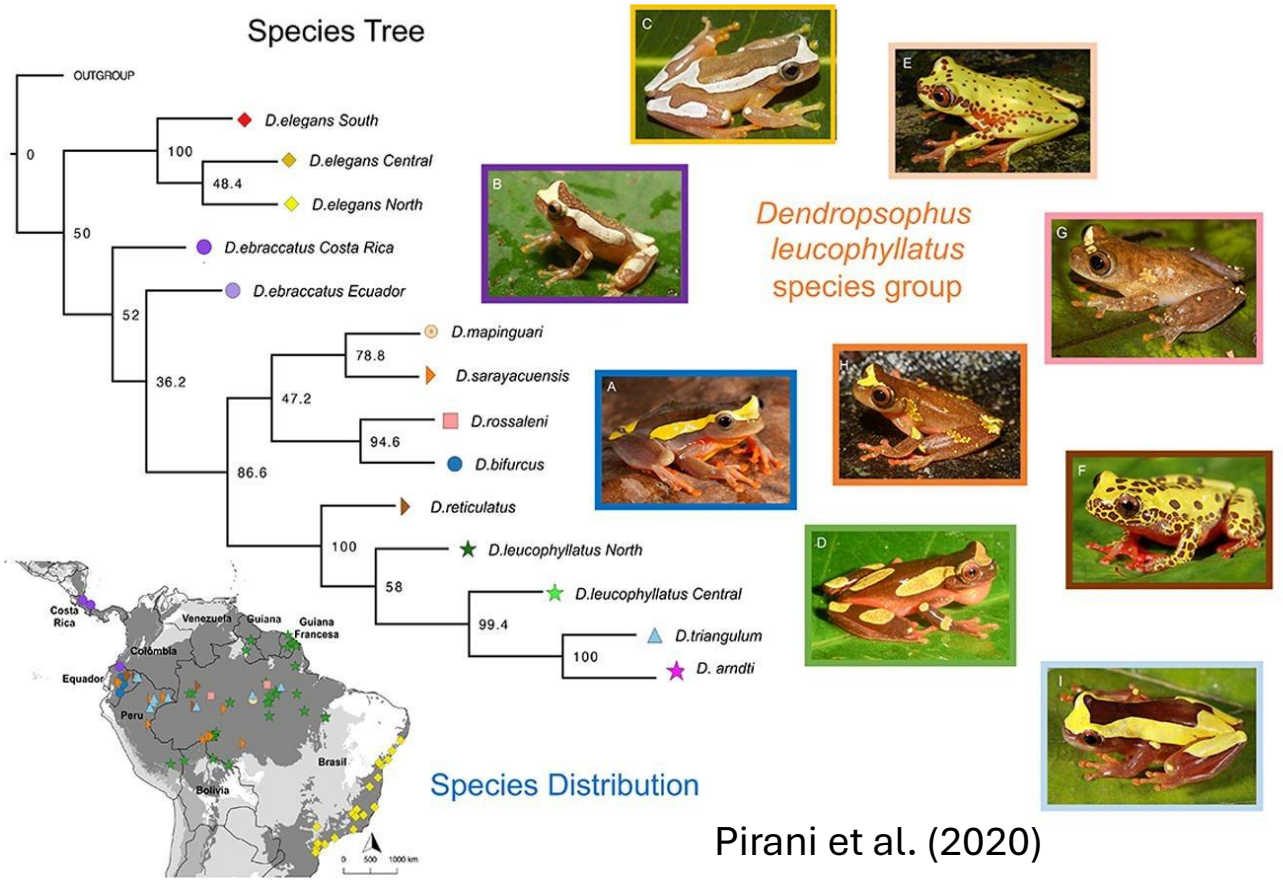
¡La matriz Q!

Un paso crucial es definir las áreas



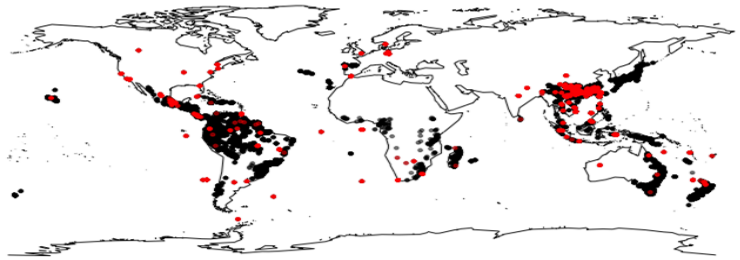
¿Qué necesitamos?

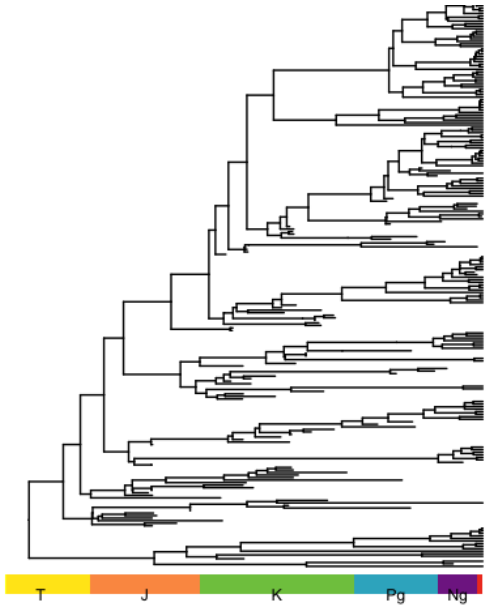
+

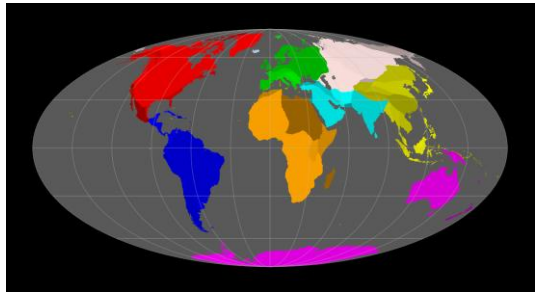


Pirani et al. (2020)

Datos para un modelo DEC







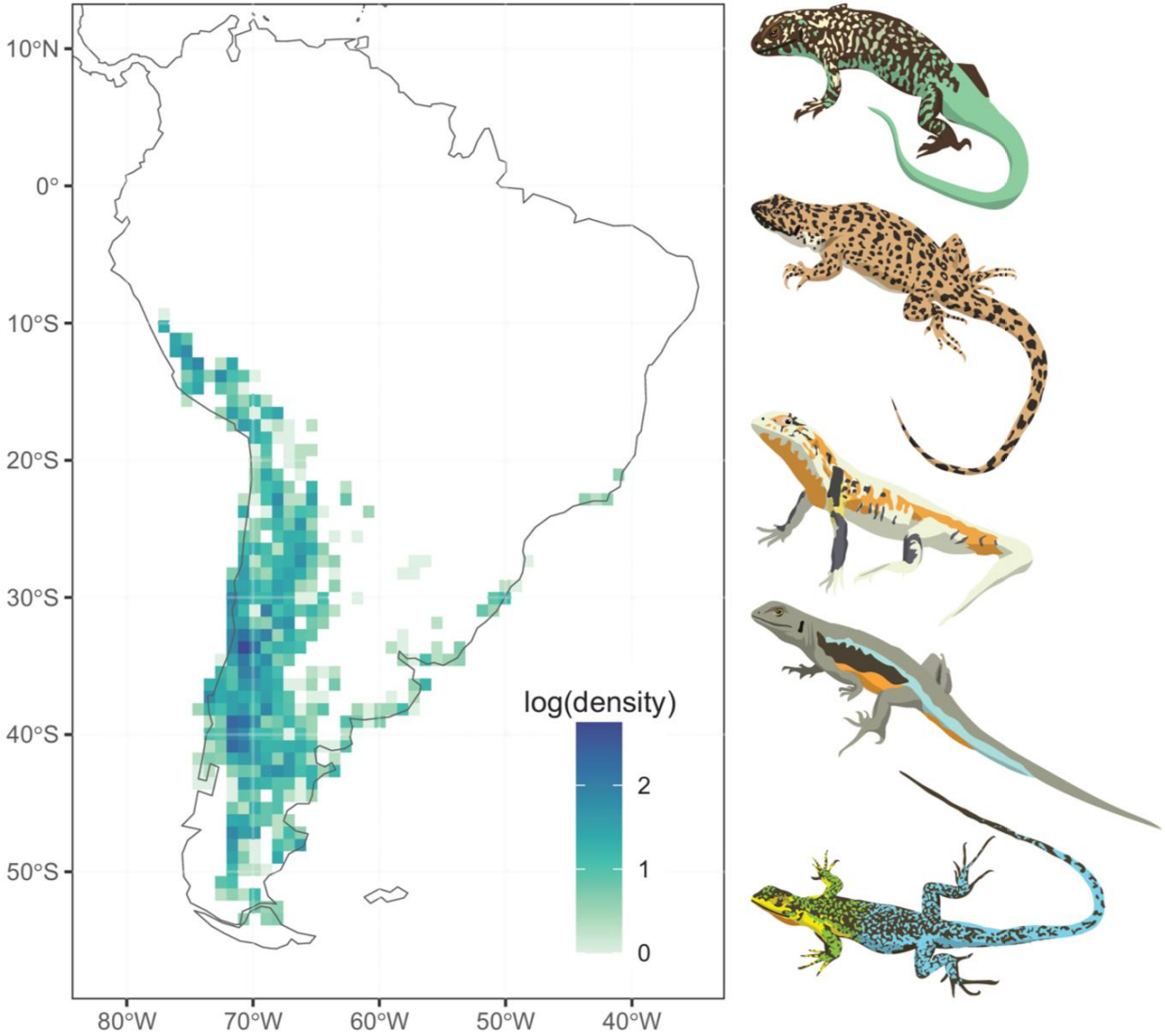
Matriz(ces) Q

Cyathea.area_graph.n8.1

	A	B	C	D	E	F	G	H
A-NAm	1	1	0	1	1	0	0	0
B-NeoTrop	1	1	1	0	1	0	0	0
C-AntPat	0	1	1	0	1	0	1	1
D-EurAsia	1	0	0	1	1	0	0	0
E-AfroTrop	1	1	1	1	1	0	0	1
F-AsiaTrop	0	0	0	0	0	1	0	0
G-AusPac	0	0	1	0	0	0	1	1
H-India	0	0	1	0	1	0	1	1

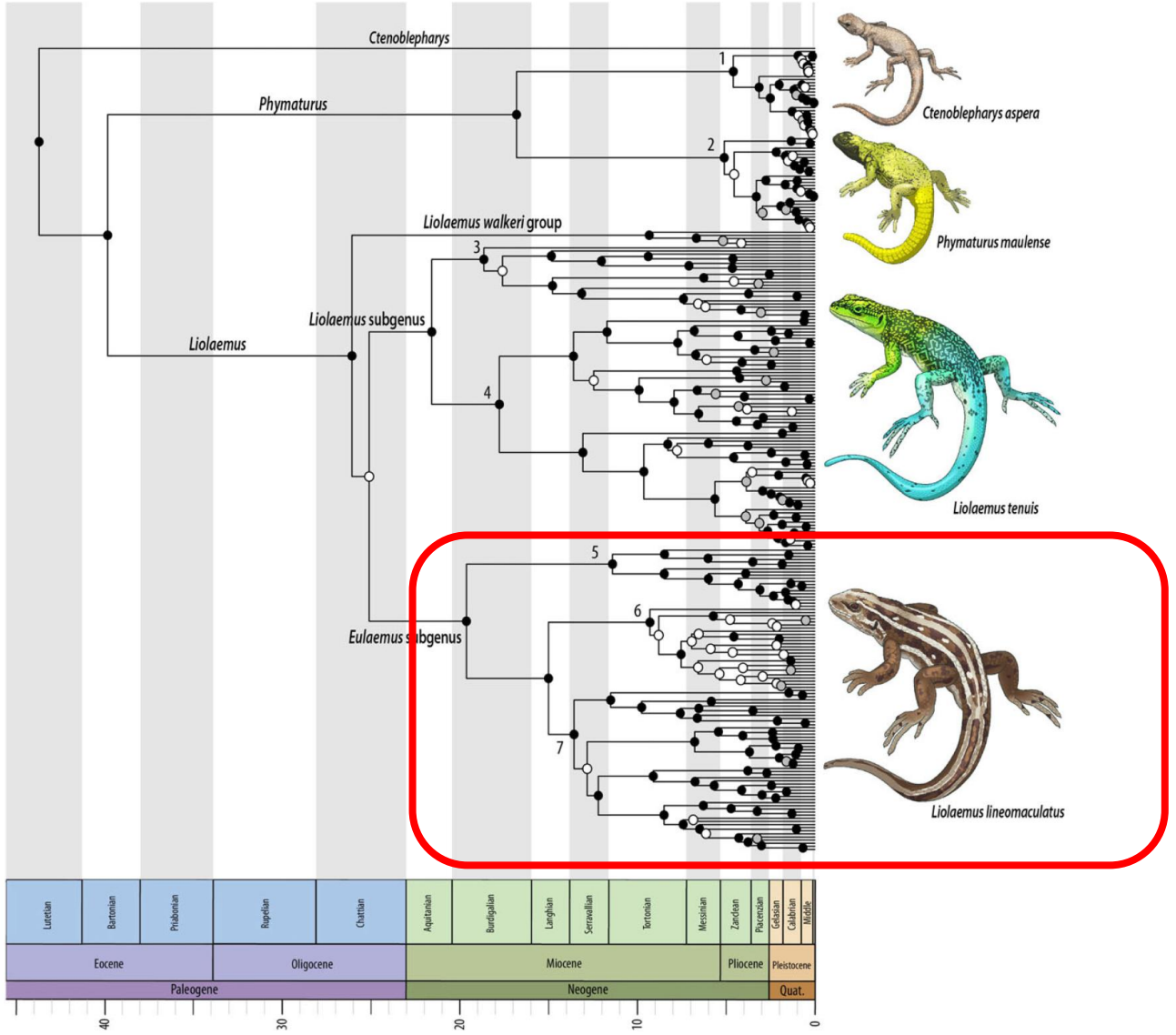
Sistema de estudio: Liolamidae

- ~300 especies descritas
- Viviparidad
- Oviviparidad



Skeels et al. (2023)

Liolamidae-*Eulaemus*



Esquerre et al. (2018)

Sistema de estudio: Liolamidae

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How mountains shape biodiversity: The role of the Andes in biogeography, diversification, and reproductive biology in South America's most species-rich lizard radiation (Squamata: Liolaemidae)

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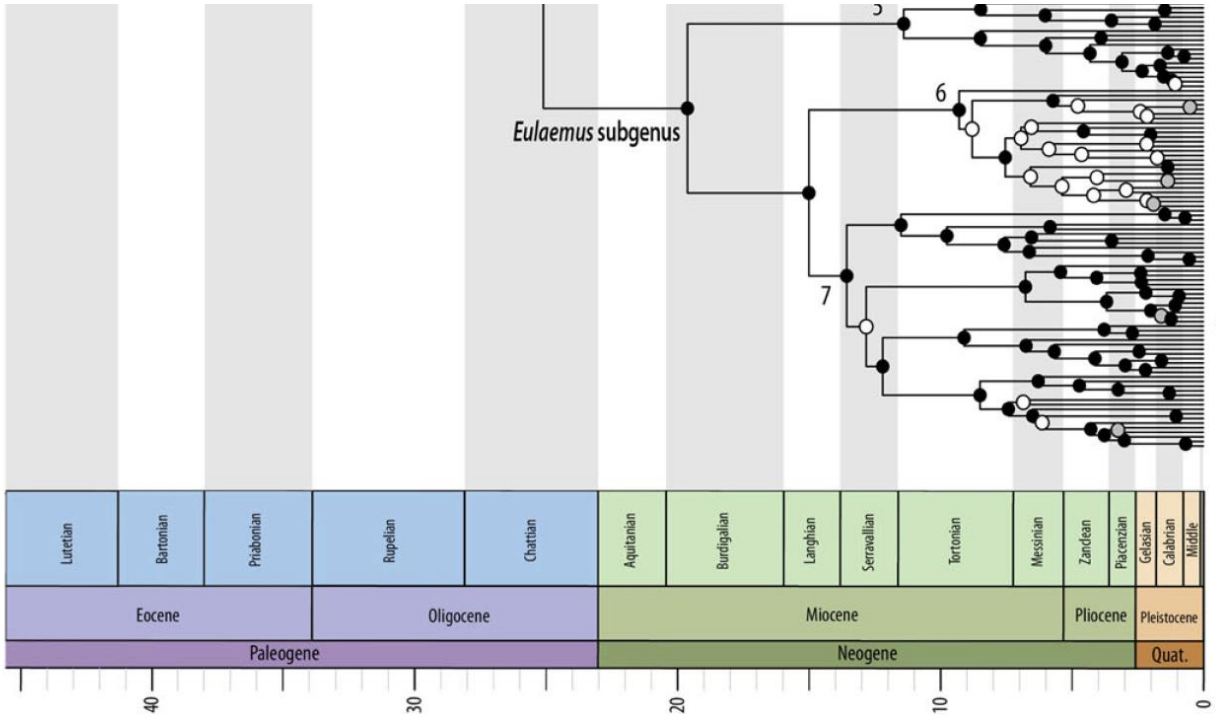
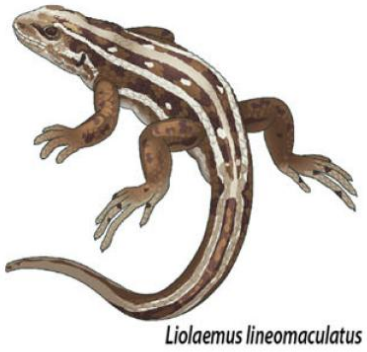
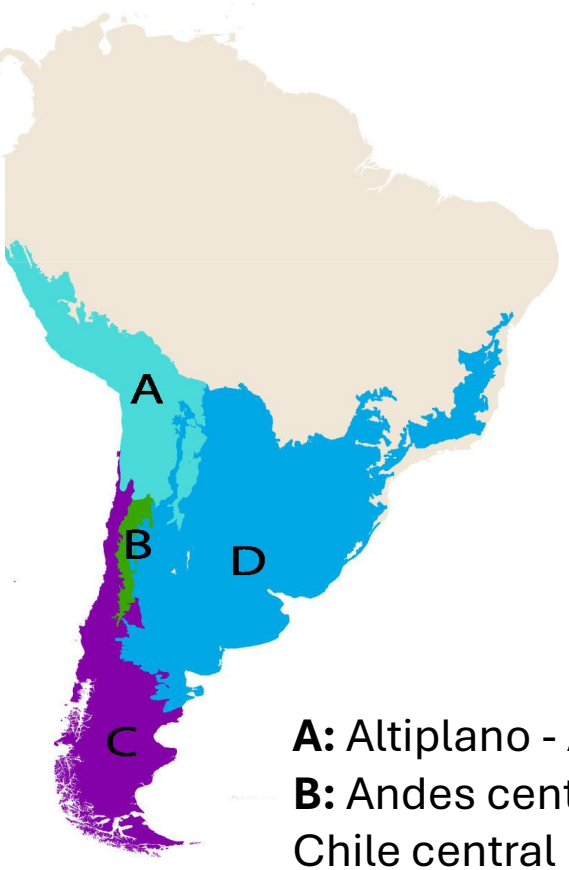
Liolamidae-*Eulaemus*




Liolaemus lineomaculatus



A: Altiplano - Atacama
B: Andes centrales-Chile central
C: Patagonia
D: Tierras bajas orientales