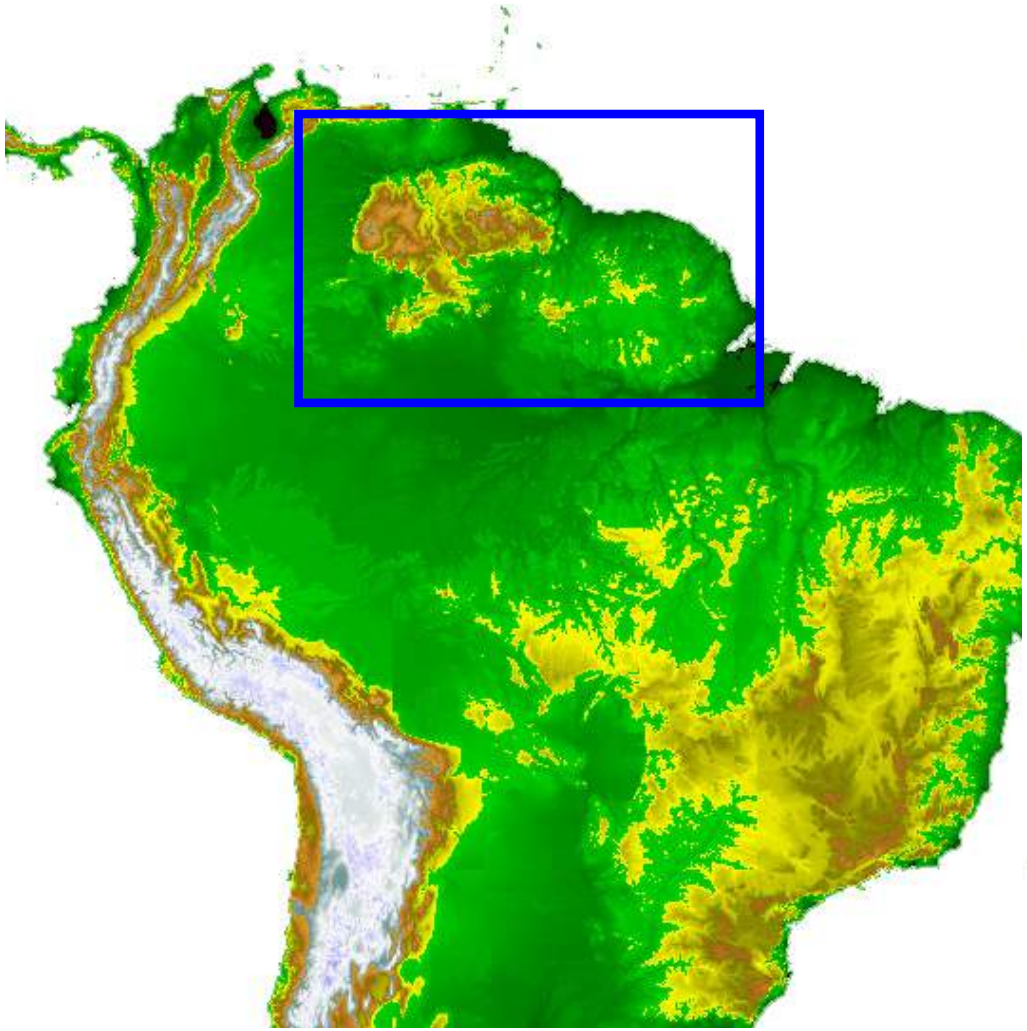
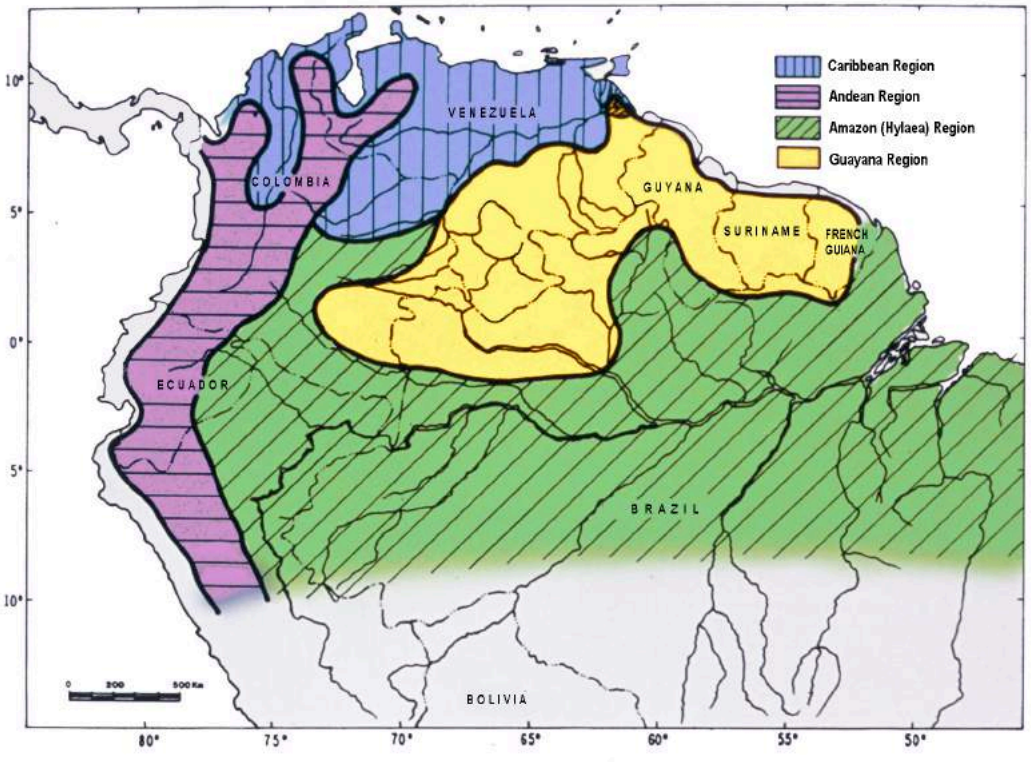

‘Islands in the Sky’

‘Islands in the Sky’ - Tepuis

- Guayana Shield centered in southern Venezuela
- 1.2 X 10^6 m^2
- sandstone table mountains of Roraima Formation

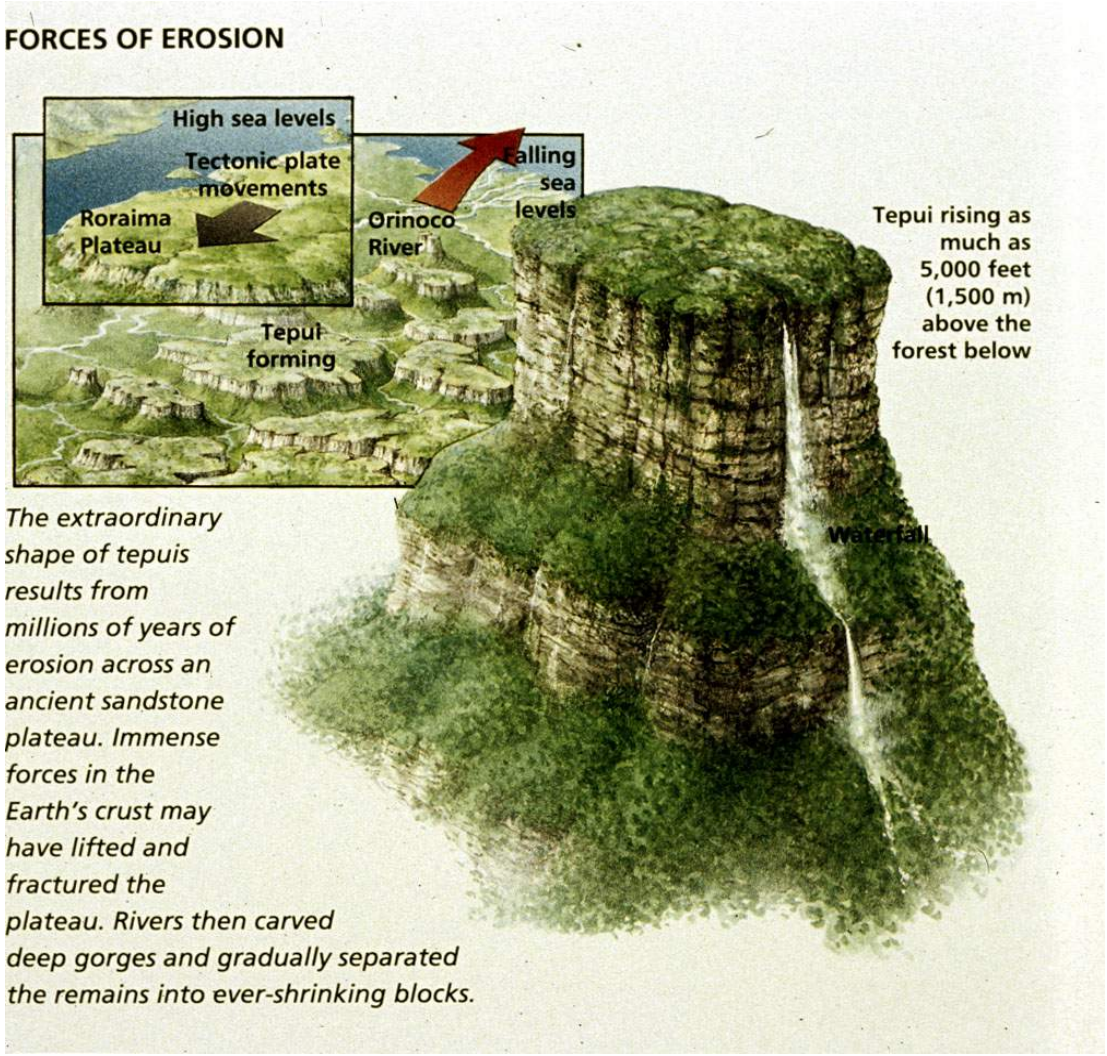


Autana, 1300 m



‘Islands in the Sky’ - Tepuis

- Roraima Formation - Precambrian, highly leached sandy marine sediments laid down 1.5 - 1.8 billions years ago

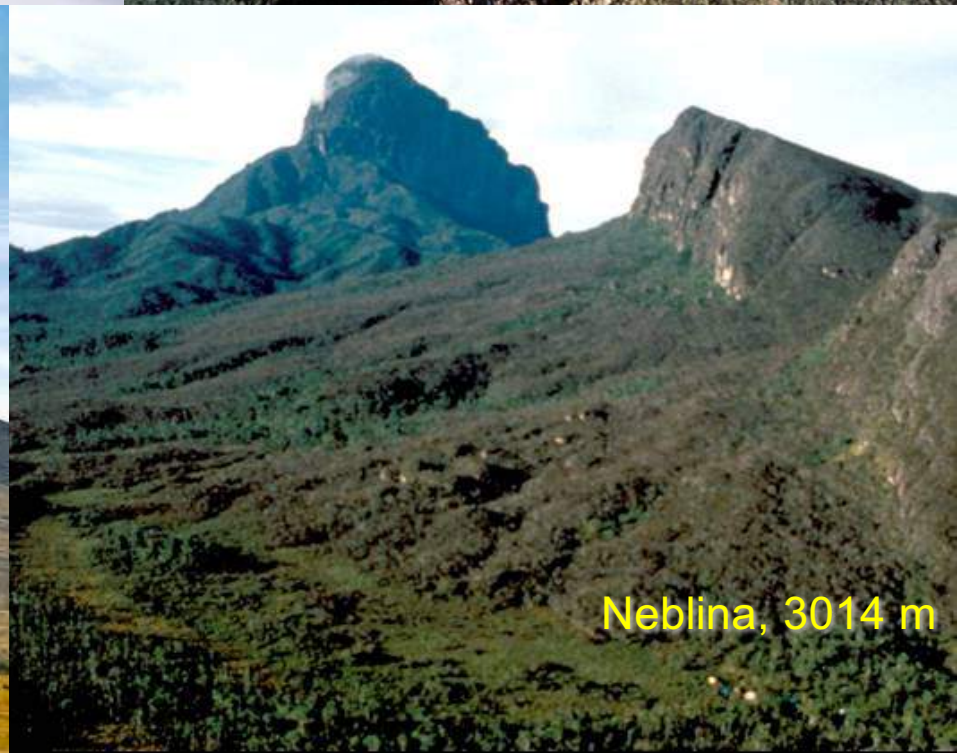


- Roraima Formation uplifted during formation of Atlantic in Cretaceous
- tepuis formed with erosion of major river systems (Orinoco) – vicariance?
- tepuis are resistant (quartzite) mesas


Roraima, 2723 m

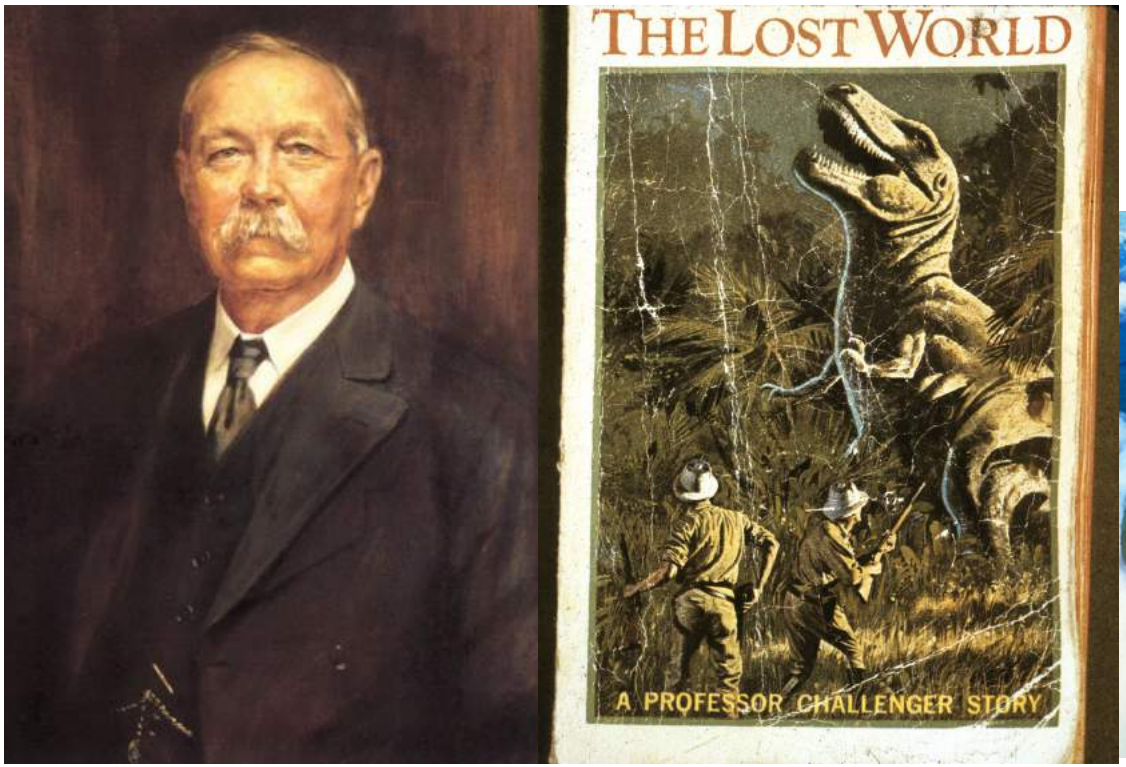

Autana, 1300 m


Kukenán, 2650 m


Neblina, 3014 m

‘Islands in the Sky’ - Tepuis

- tepuis basis for Sir Arthur Conan Doyle’s “The Lost World”
- actually home to one of the world’s largest set of plant “carnivores”

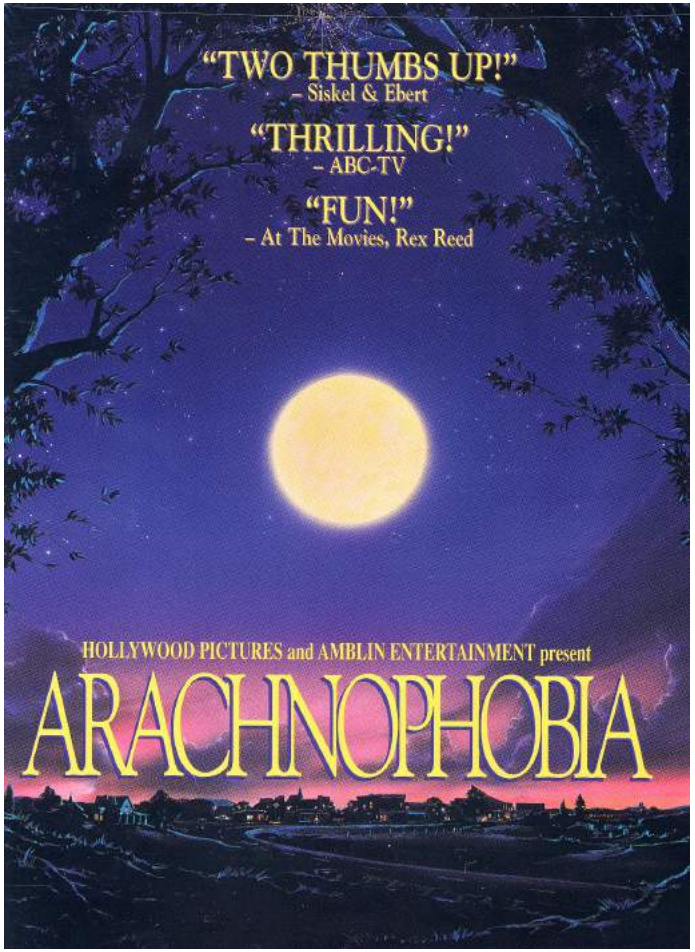


Heliamphora - sun pitcher

‘Islands in the Sky’ - Tepuis

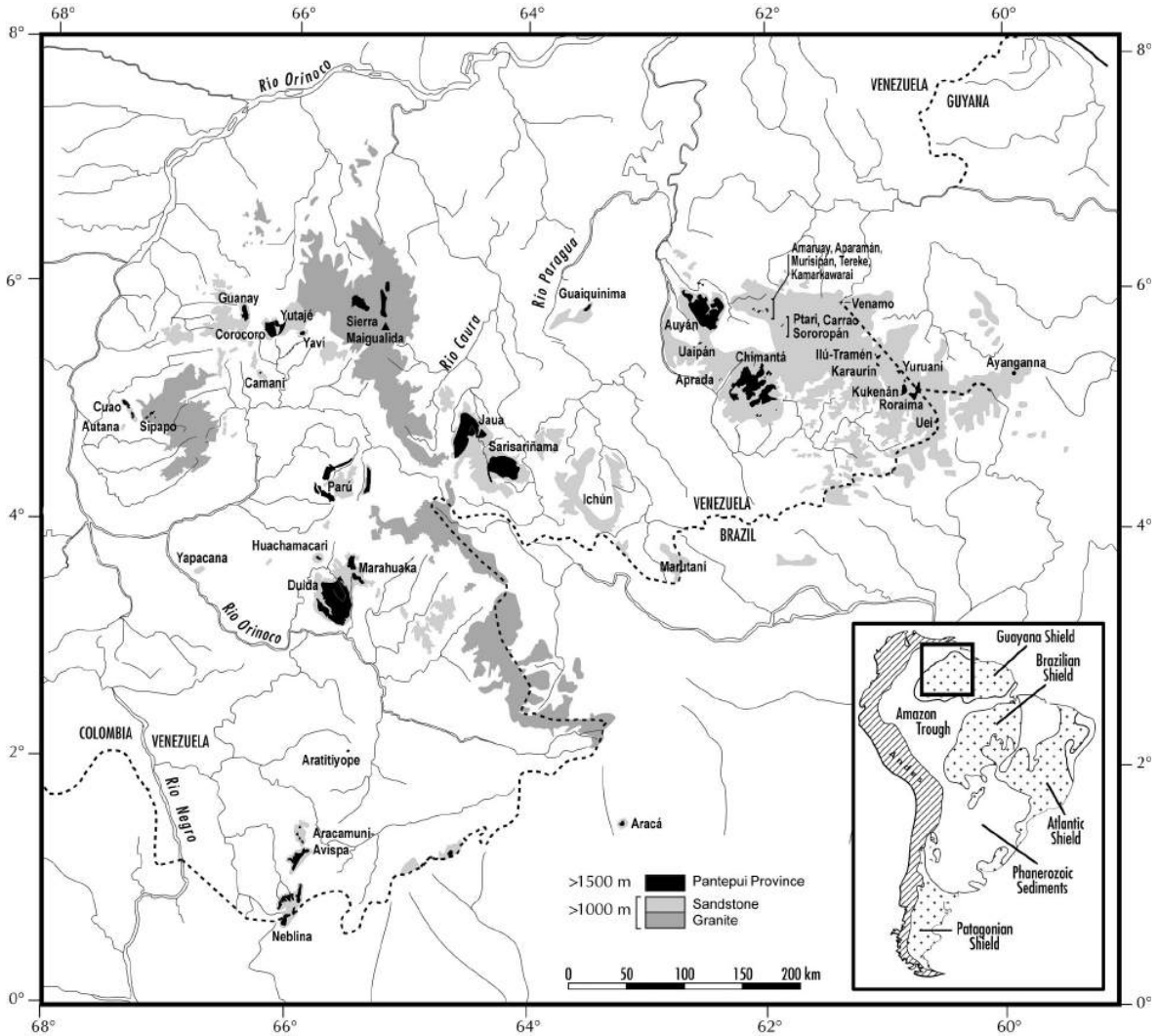
- tepuis basis for opening scene of *Arachnophobia*

Canaima National Park



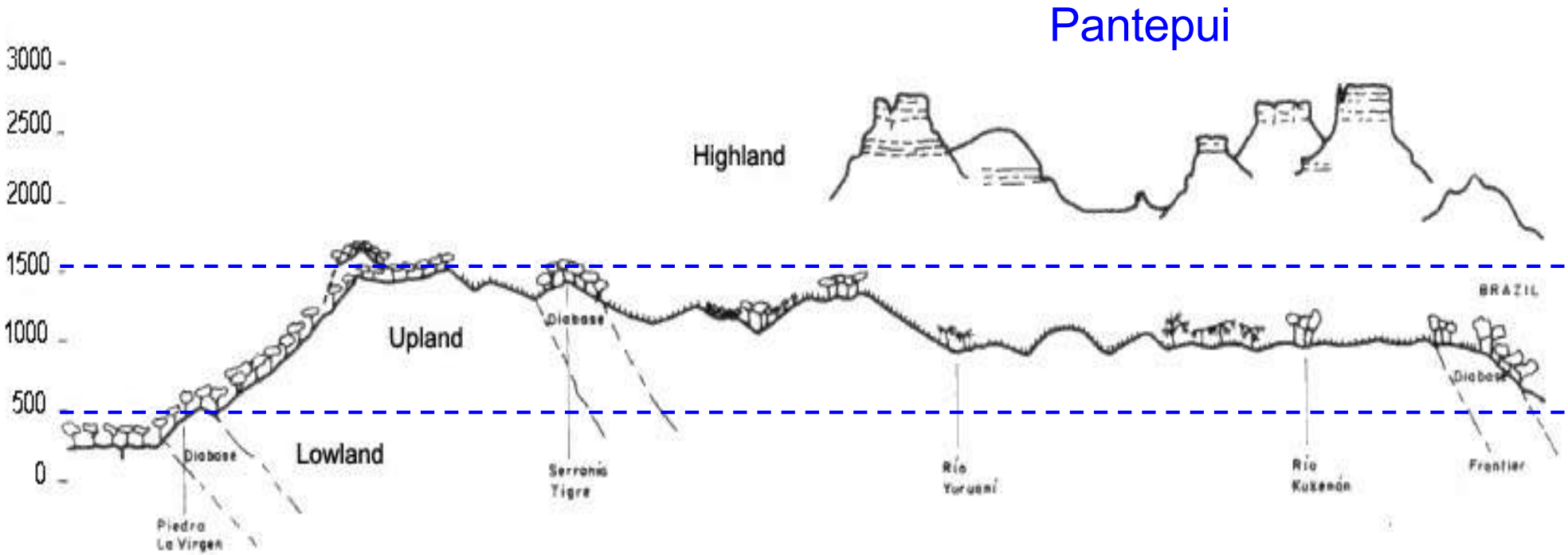
‘Islands in the Sky’ - Tepuis

- Pantepui - biogeographic province proposed by the Phelps for high elevation “island” portion over 1500 m



‘Islands in the Sky’ - Tepuis

- Pantepui - biogeographic province proposed by the Phelps for high elevation “island” portion over 1500 m
- characterized by a combination of extreme conditions: cool weather, heavy rainfalls, dense clouds, strong winds, high solar radiation, and extremely infertile substrates



‘Islands in the Sky’ - Tepuis

- Pantepui - biogeographic province proposed by the Phelps for high elevation portion over 1500 m
- Distinctive biota

Tepui vireo

Redbanded fruiteater

Tepui manakin

Rana

Asteraceae

Tepui Flora

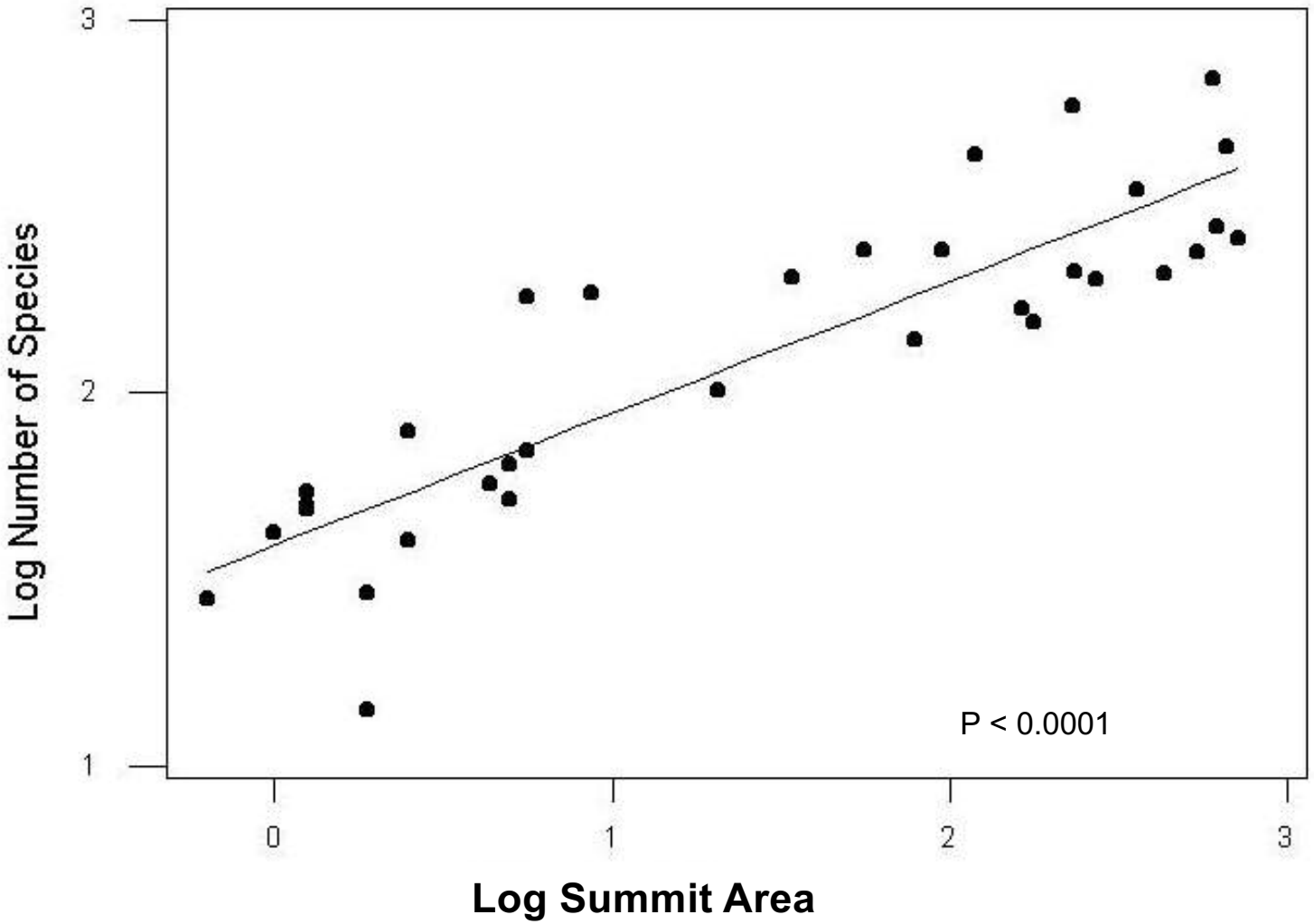
Do the tepuis function as islands?

Ricarda Riina
M.S. thesis (2003)

Tepui Flora

- Pantepui - island like species/area relationship

Riki Olivares - M.S. thesis



Tepui Flora

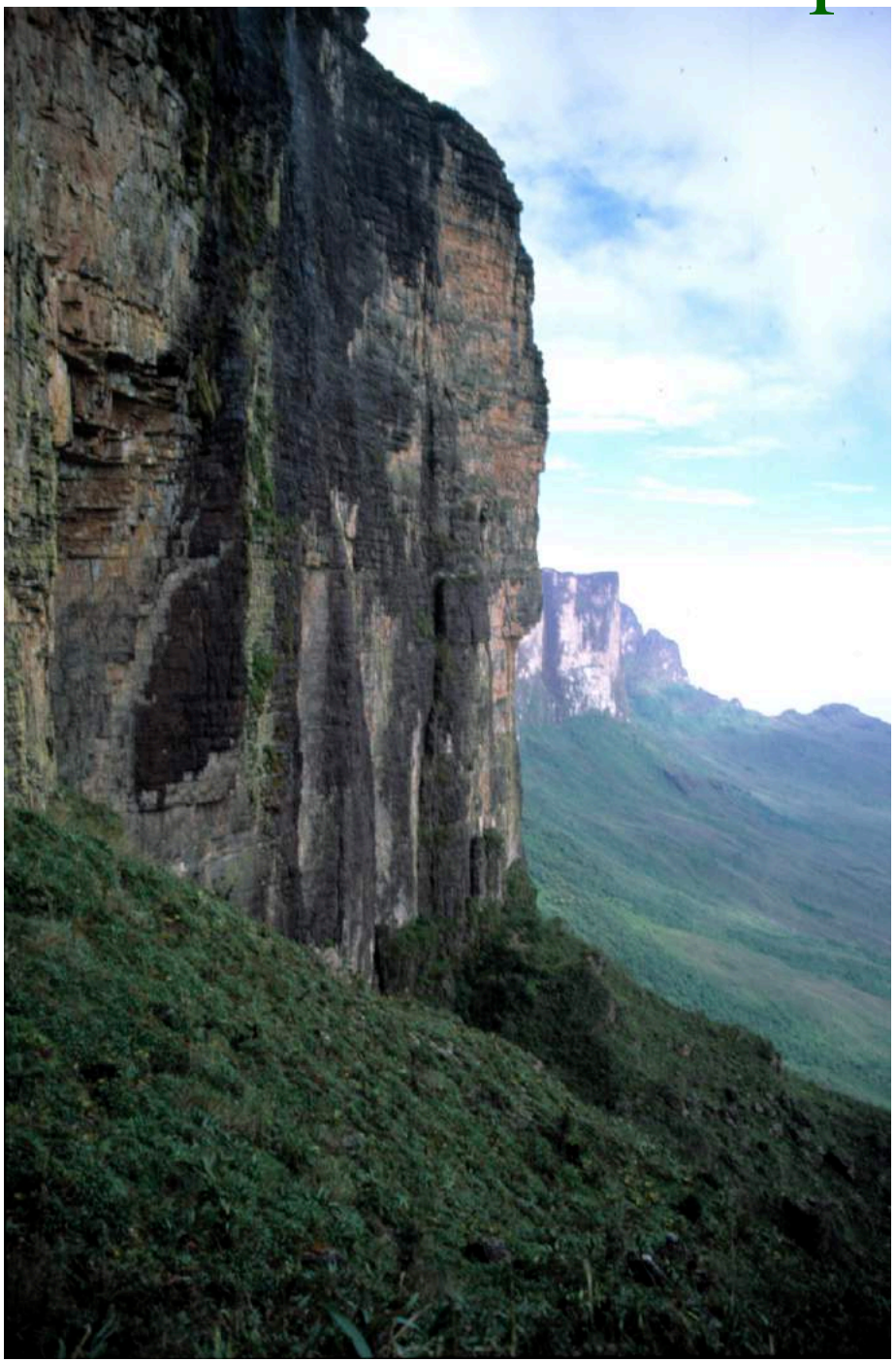
- Pantepui - island like endemism

Overall plant richness and endemism

	Pantepui taxa	**Shield endemics**	**Pantepui endemics**	**Single tepui endemics**
Families	156	2	0	0
Genera	626	80	23 (4%)	13 (2%)
Species	2447	1517	1034 (42%)	617 (25%)

Riki Olivares - M.S. thesis

Tepui Flora



- Floristic relationships among tepuis

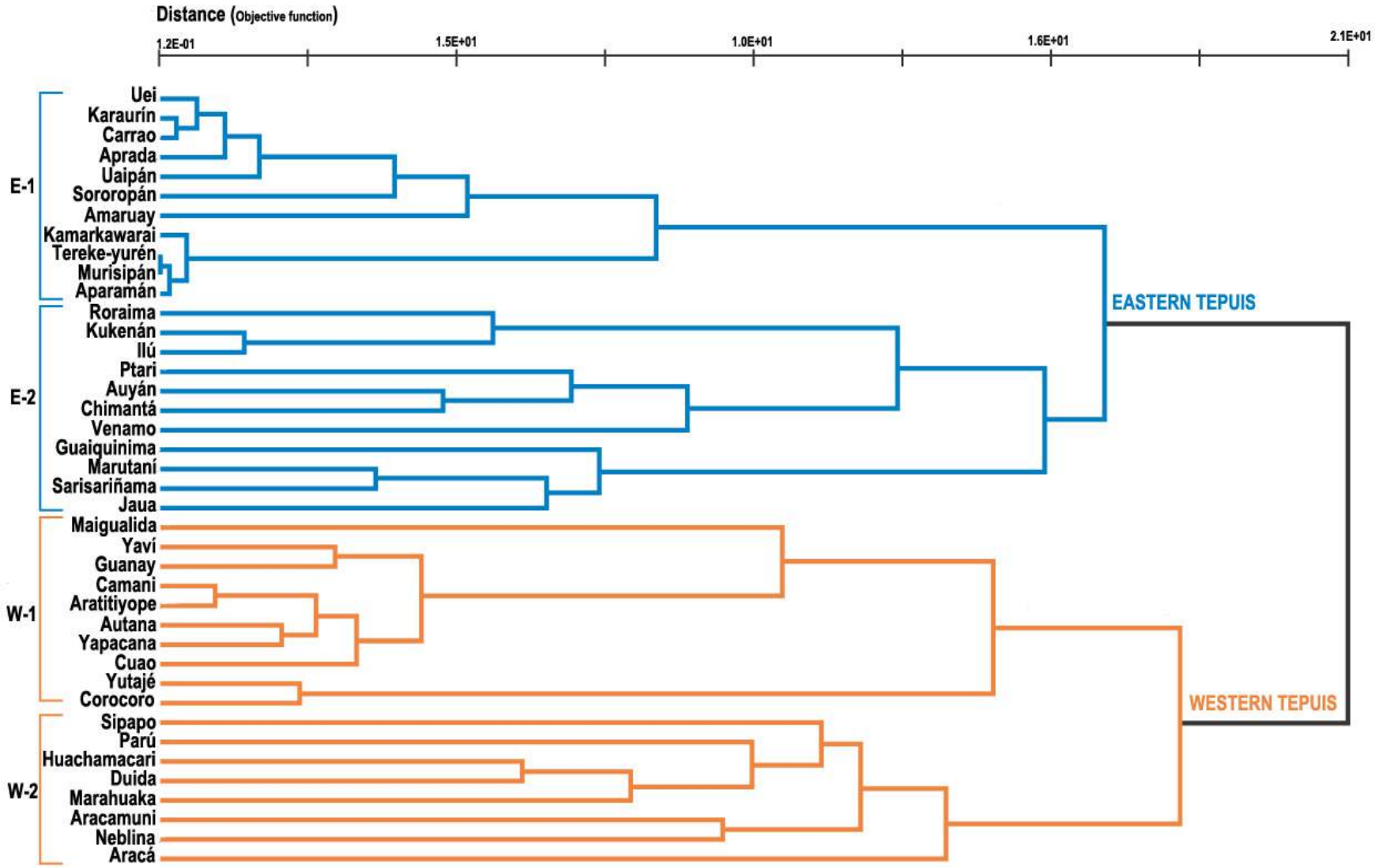
- Is there a biogeographical pattern?

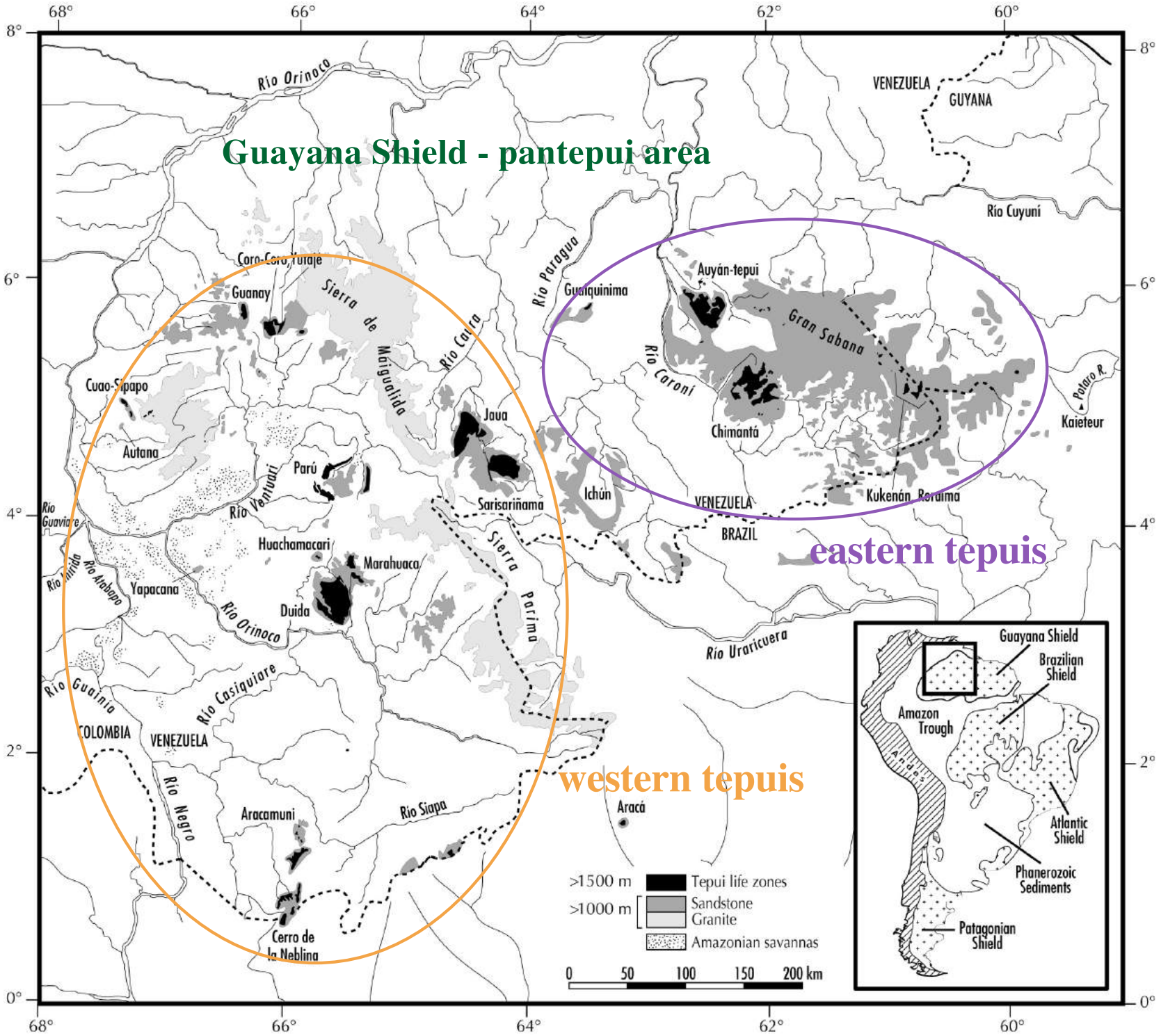
– vicariance formed by river erosion?

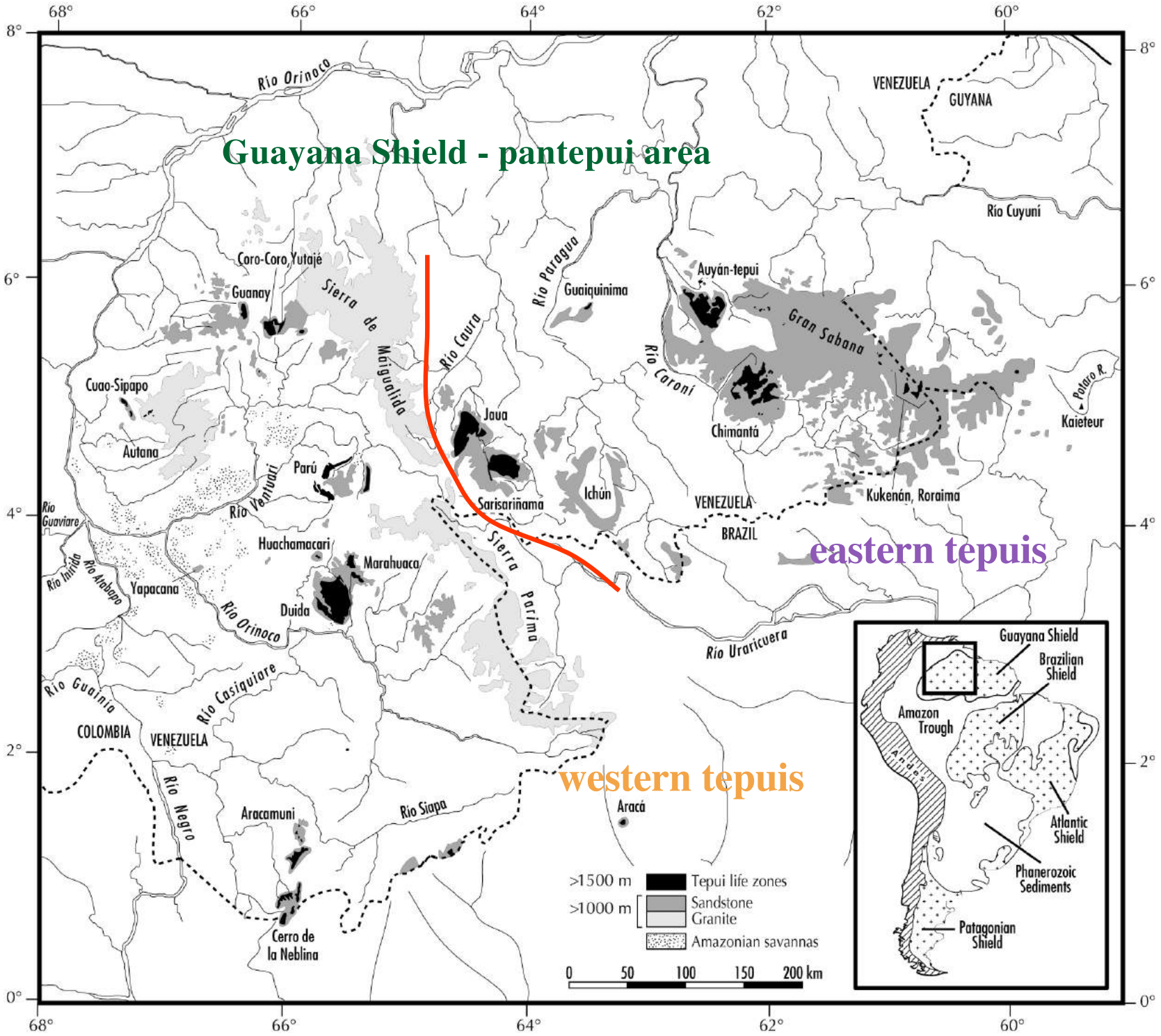
Vicki Funk - Smithsonian

Tepui Flora

Cluster Analysis based on floristic composition




Guayana Shield - pantepui area
eastern tepuis
western tepuis
Río Orinoco
VENEZUELA
GUYANA
Río Cuyuní
Río Paragua
Auyán-tepui
Guaiquinima
Gran Sabana
Río Caroní
Chimantá
Kaieteur
Polaro R.
Kukenán, Roraima
Ichún
VENEZUELA
BRAZIL
Río Caura
Sierra de Maigualida
Jaua
Sarisariñama
Sierra Parima
Río Ventuari
Parú
Autana
Cuao-Sipapo
Guanay
Coro-Coro, Yutaje
Río Guaviare
Río Atabapo
Río Inírida
Yapacana
Huachamacari
Marahuaca
Duida
Río Orinoco
Río Guainía
Río Casiquiare
COLOMBIA
VENEZUELA
Río Negro
Aracamuni
Cerro de la Neblina
Río Siapa
Aracá
Río Uraricuera
>1500 m
Tepui life zones
>1000 m
Sandstone
Granite
Amazonian savannas
0 50 100 150 200 km
Guayana Shield
Brazilian Shield
Amazon Trough
Andes
Atlantic Shield
Phanerozoic Sediments
Patagonian Shield
68°
66°
64°
62°
60°
8°
6°
4°
2°
0°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68°
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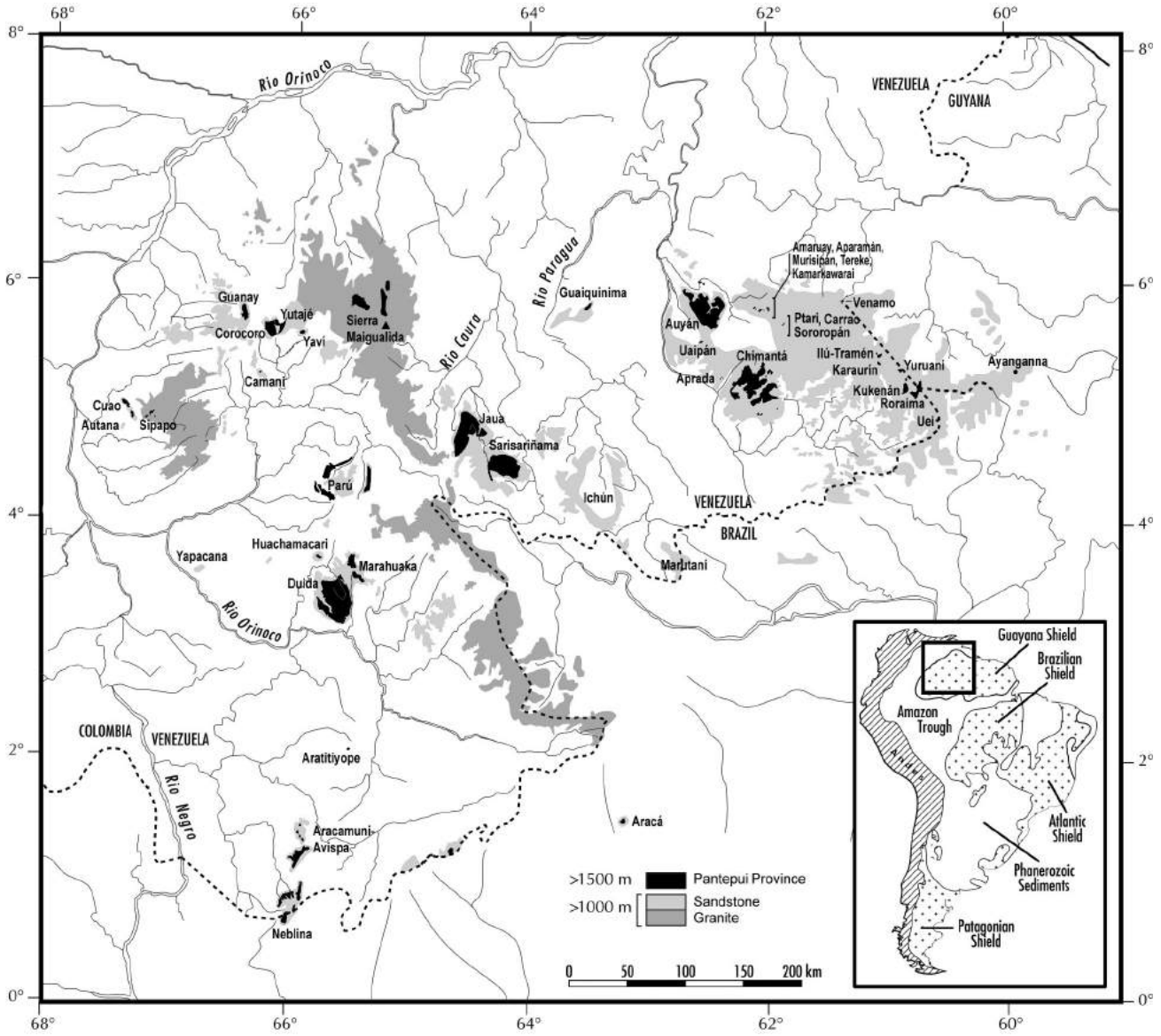
0°

Tepui Flora

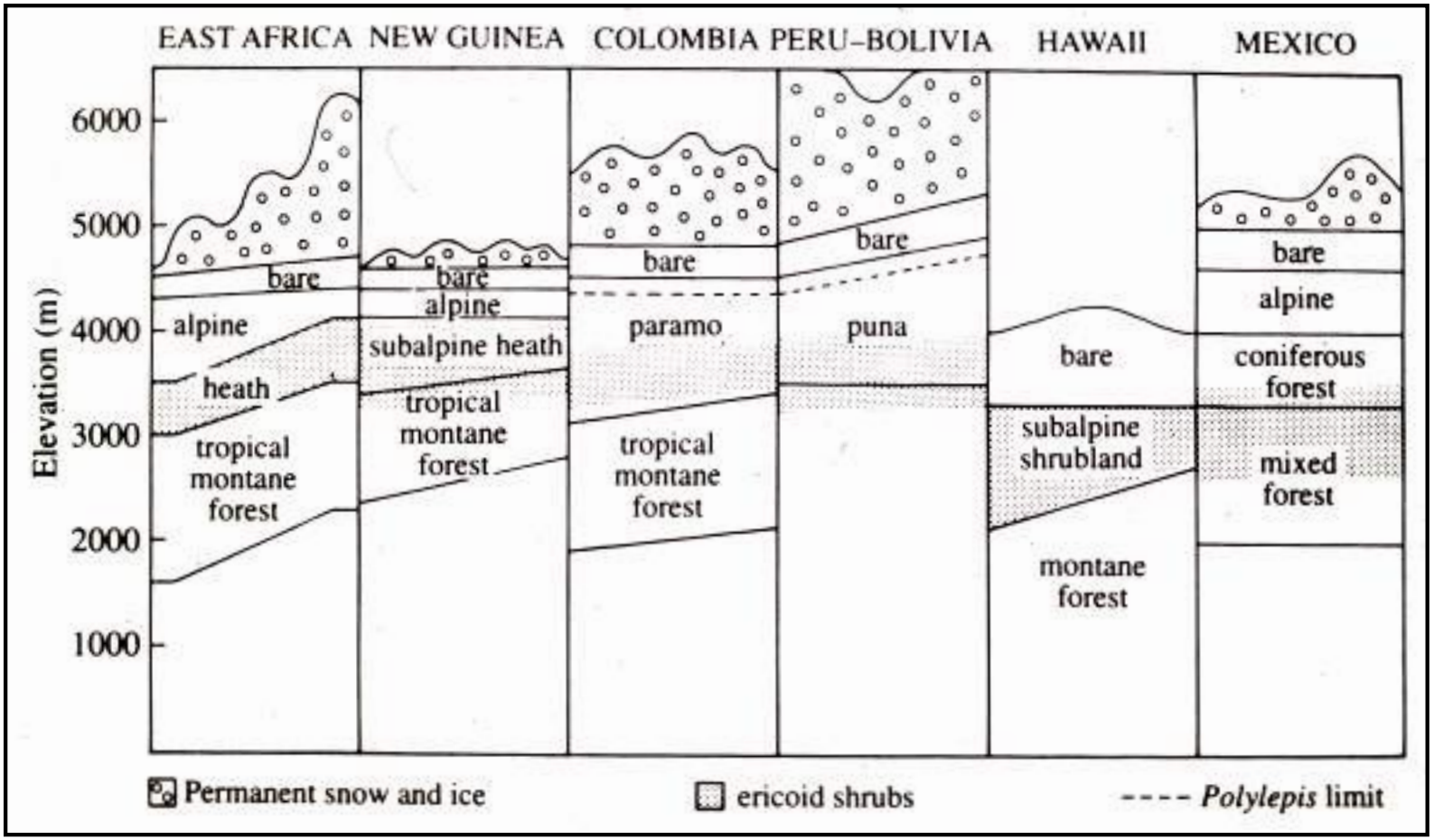
- positive significant (P = 0.001) correlation between the floristic distance matrix and the among-tepuis geographic distance matrix (Mantel Test)




‘Islands in the Sky’ - Paramo, Afroalpine

‘Islands in the Sky’ - Paramo, Afroalpine

- convergent biome types across high elevation areas of the tropics
- depending on elevation, often occur as ‘islands’



‘Islands in the Sky’ - Paramo, Afroalpine

- South American paramo and East African afroalpine (‘Ethiopian’) best studied floristically as islands

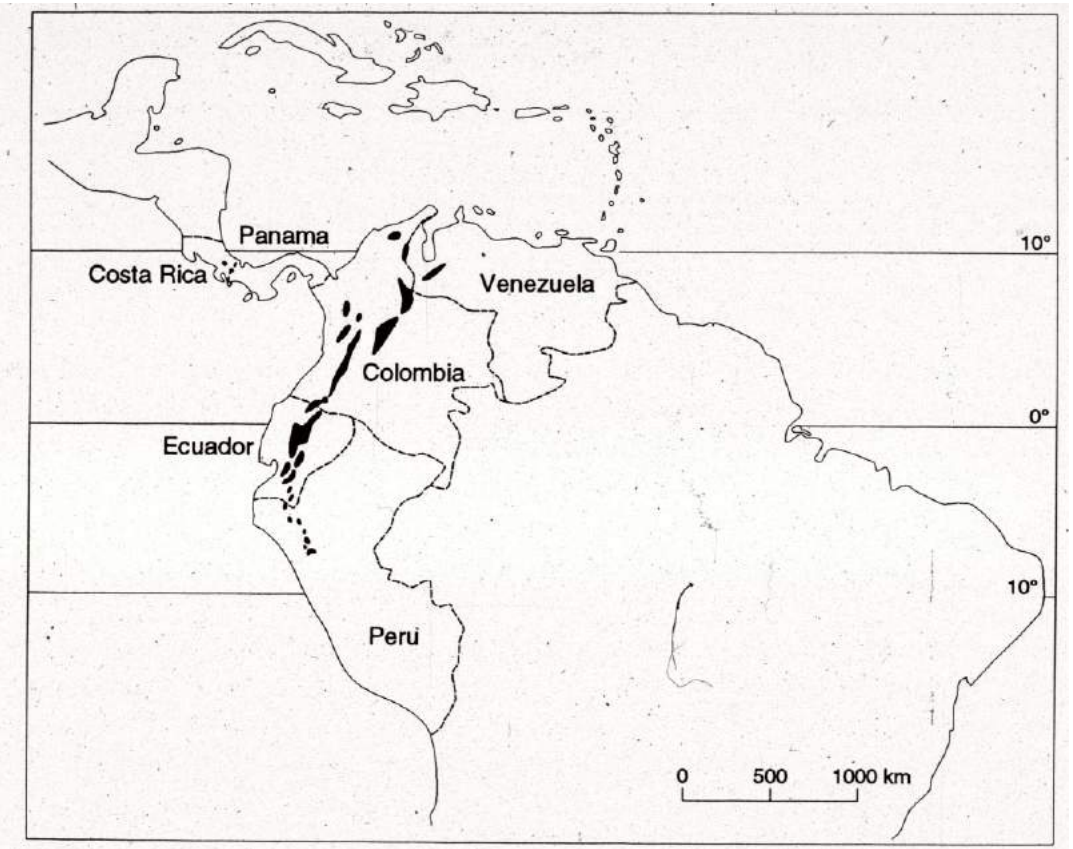


Figure 1. Distribution of páramos in the Neotropics along the cordilleras from Costa Rica and Panama to northern Peru.

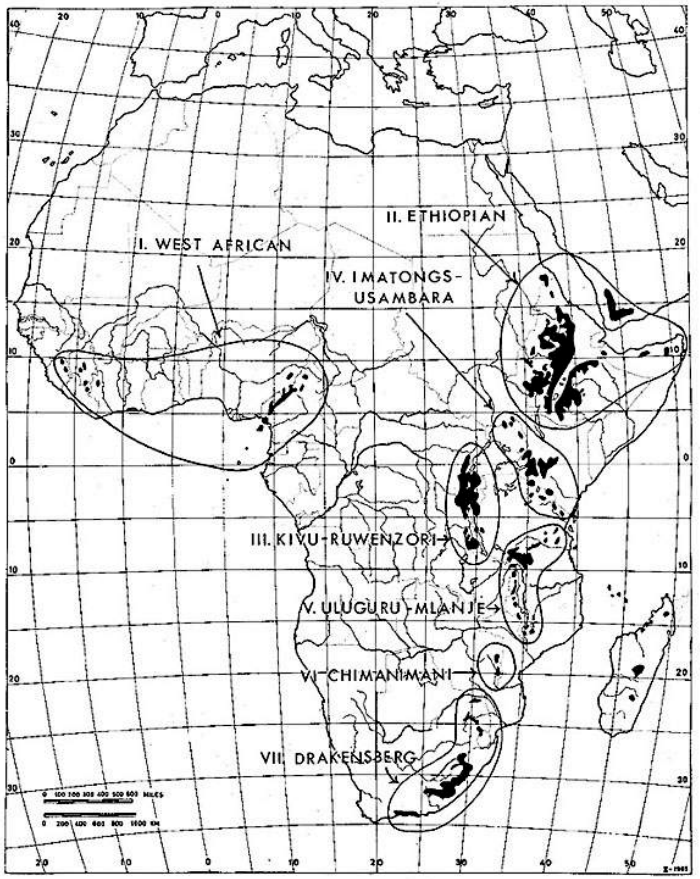


Fig. 1. Map. showing distribution of the islands of the Afromontane archipelago in the seven regional mountain systems. The distribution of montane vegetation in Madagascar is also shown.

‘Islands in the Sky’ - Paramo, Afroalpine

- ecology is harsh and unvarying: ‘winter by night, summer by day’

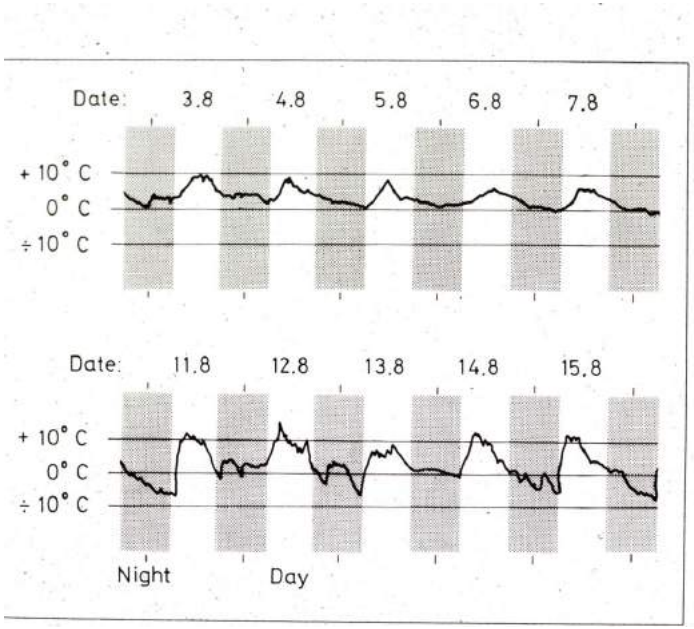


Figure 2. Thermograms from Teleki Valley, Mt. Kenya (4200 m). Upper thermogram recorded on the valley slope, 50 cm above the ground between a few big boulders. Lower one obtained on flat valley bottom, 10 cm above the surface, in shadow of *Dendrosenecio keniensis* leaves. Horizontal distance is 50 m; difference in altitude is less than 5 m (modified from Hedberg, 1964b).

‘Islands in the Sky’ - Paramo, Afroalpine

- Convergent life forms occur in both areas as a response to these ecological conditions

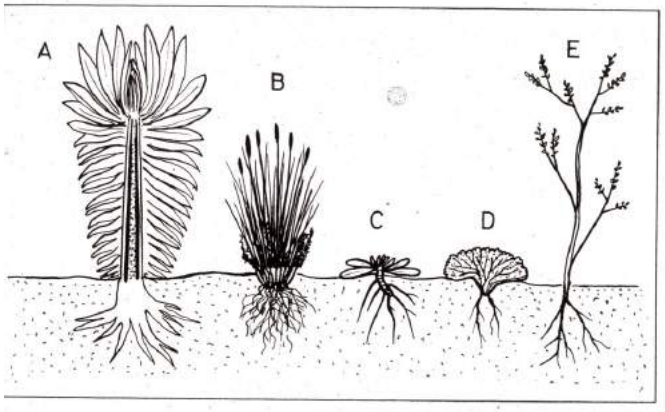


Figure 3. The five most important life forms of the afroalpine belt. **A.** giant rosette plant, **B.** tussock grass, **C.** acaulescent rosette plant, **D.** cushion plant, **E.** sclerophyllous shrub (modified from Hedberg, 1964a).

Hypericum (sclerophyll)

tussock grass

Acaena (rosette)

Erica (sclerophyll)

Viola (cushion)

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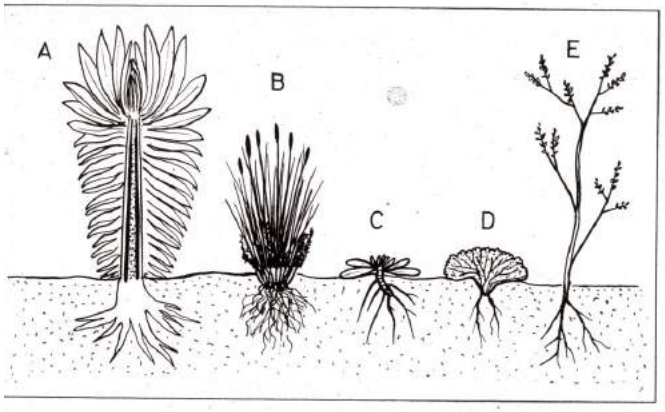
- Convergent life forms occur in both areas as a response to these ecological conditions

Afroalpine



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Dendrosenecio (Asteraceae)

Lobelia (Lobeliaceae)

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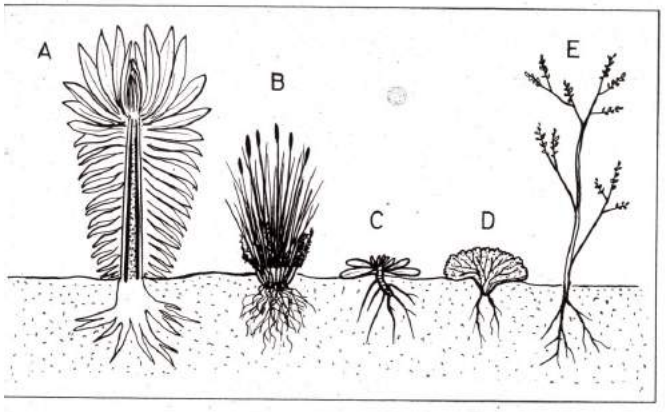

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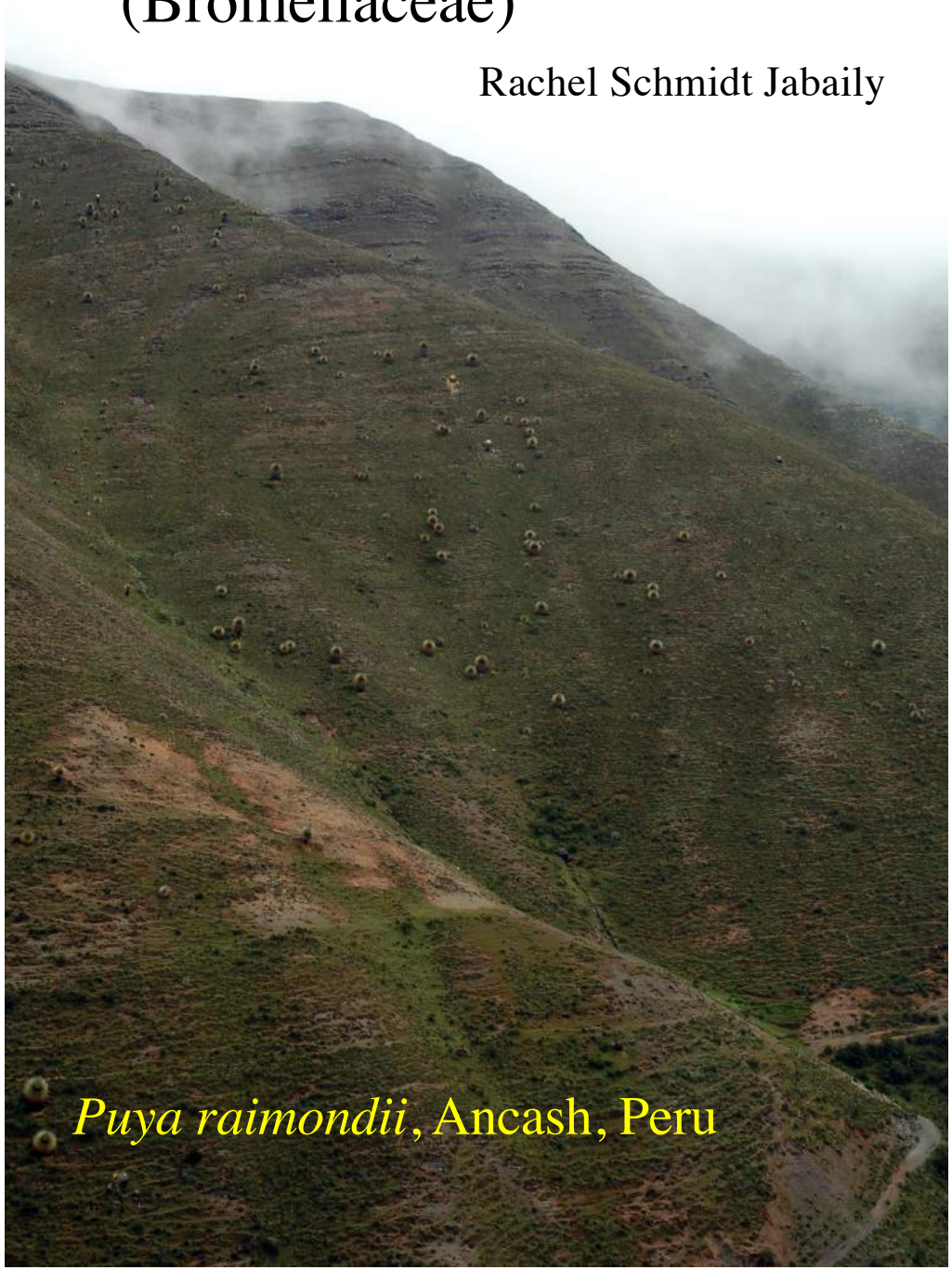
Paramo

Puya (Bromeliaceae)

Espeletia (Asteraceae)

Radiation in Andean *Puya* (Bromeliaceae)

Rachel Schmidt Jabaily



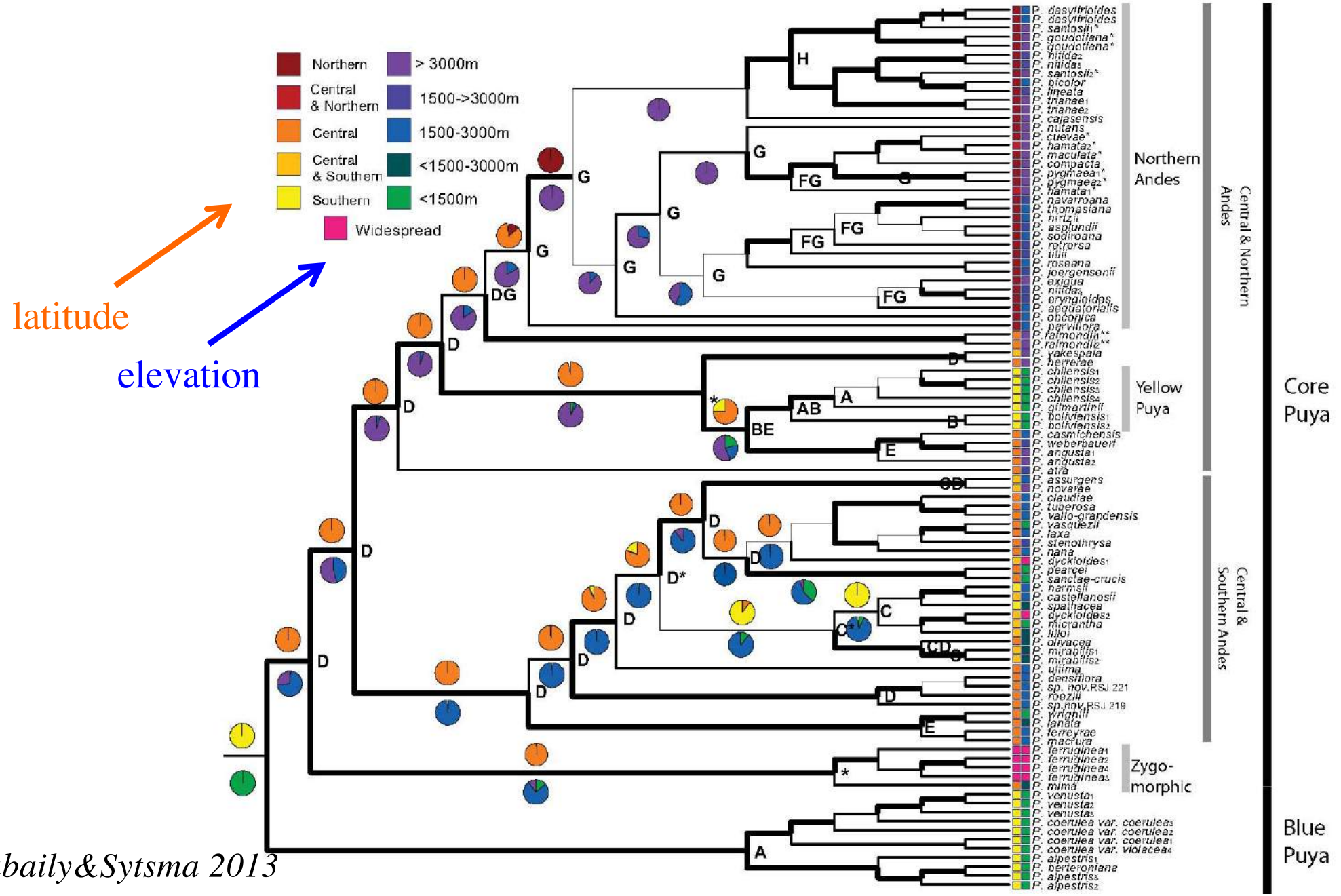
Puya raimondii, Ancash, Peru

Radiation in Andean *Puya* (Bromeliaceae)

Direction of latitudinal and elevation shifts?

Radiation in Andean *Puya* (Bromeliaceae)

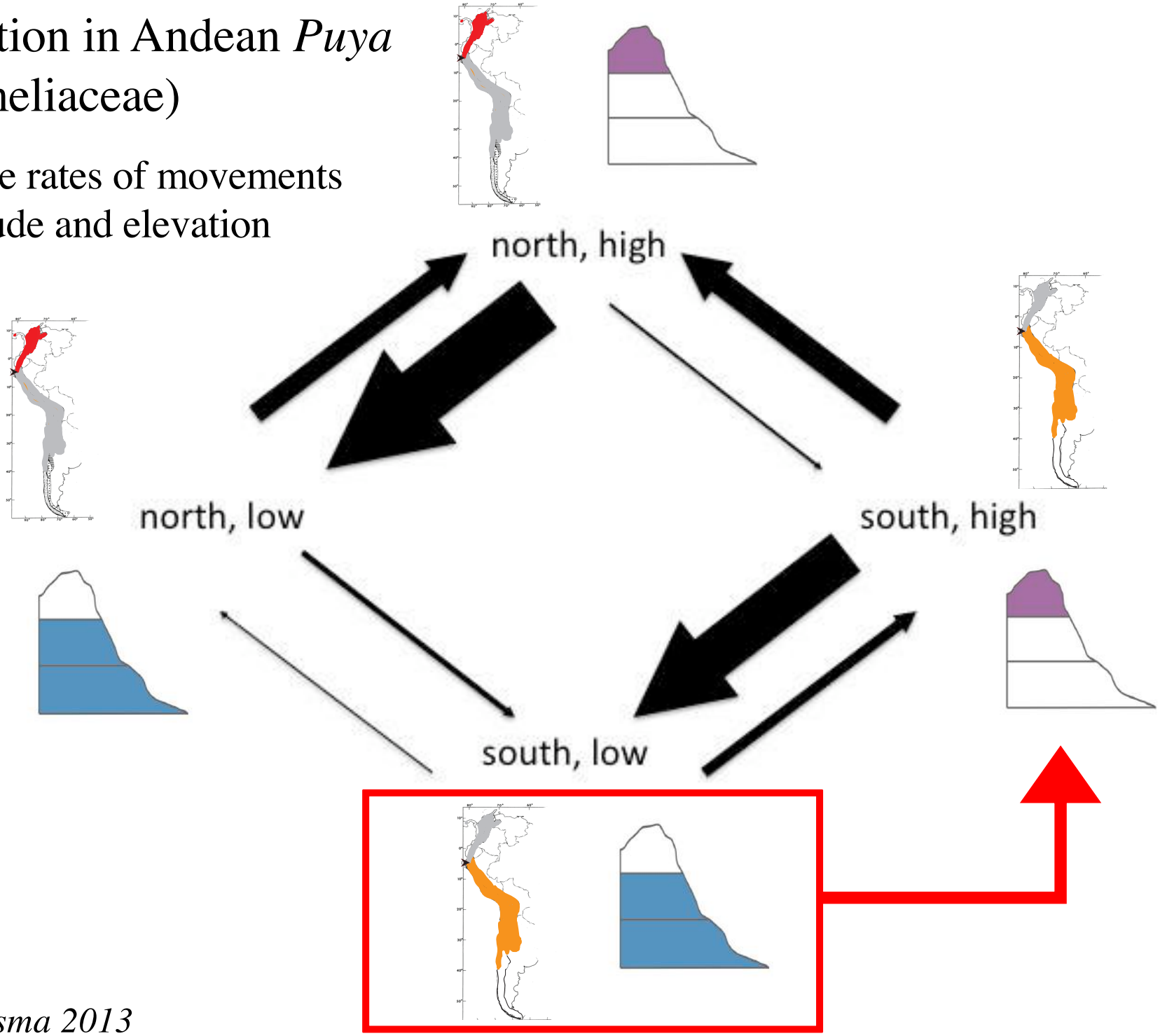
"mapping" on latitude & elevation on DNA tree



Jabaily&Sytsma 2013

Radiation in Andean *Puya* (Bromeliaceae)

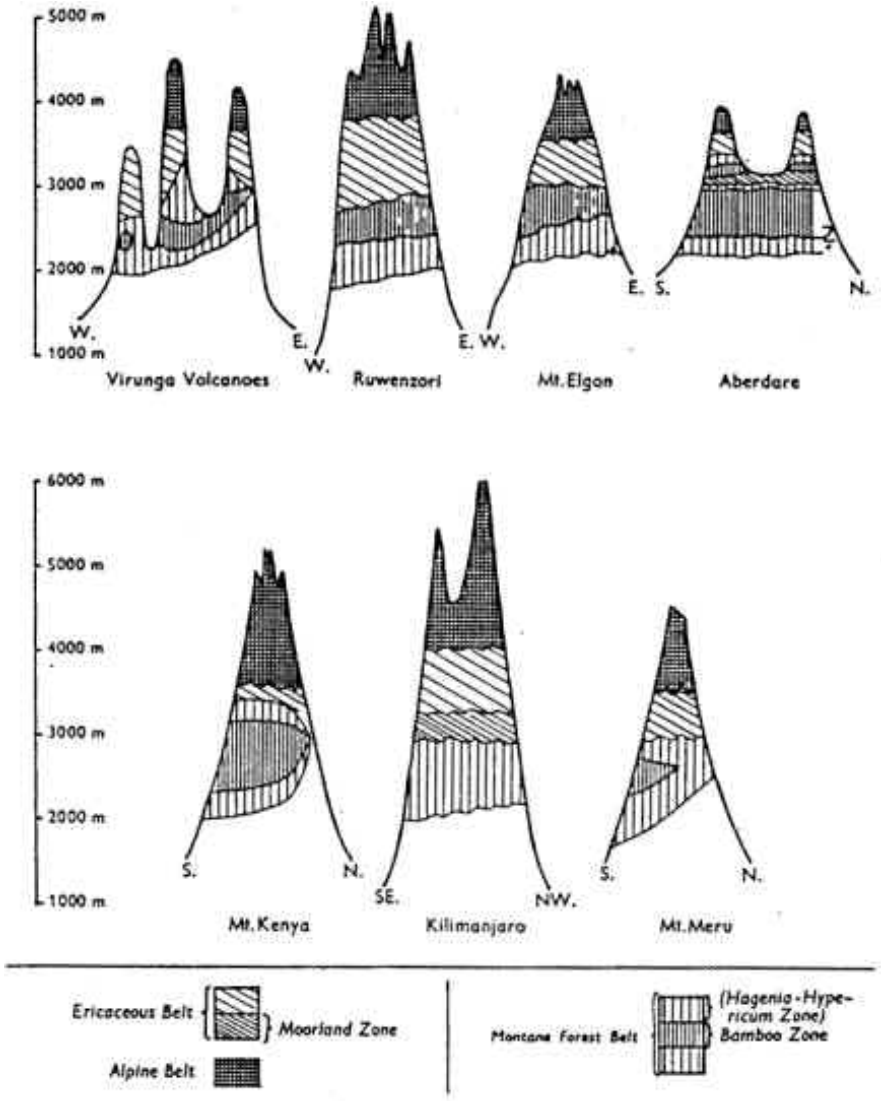
Relative rates of movements in latitude and elevation



Jabaily&Sytsma 2013

‘Islands in the Sky’ - Paramo, Afroalpine

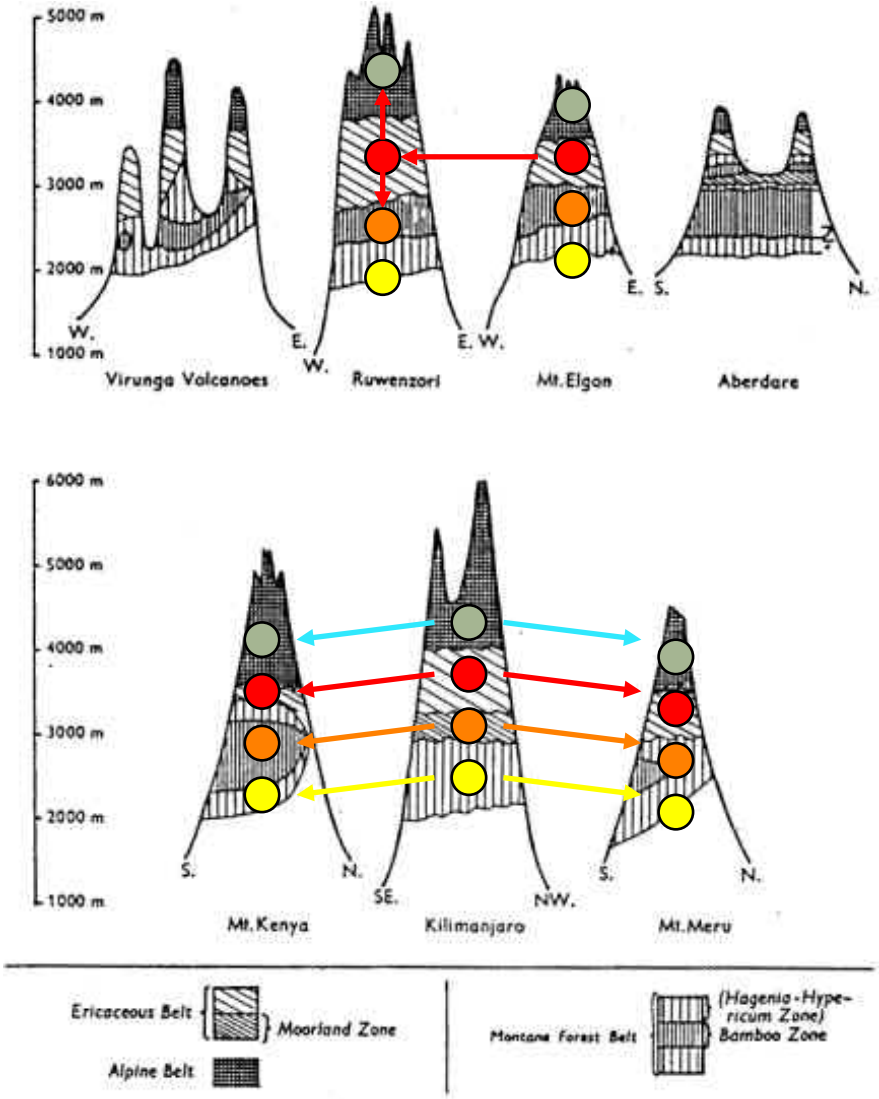
- Biogeography of afroalpine flora – adaptive radiation of *Dendrosenecio* (Asteraceae)



‘Islands in the Sky’ - Paramo, Afroalpine

- Biogeography of afroalpine flora – adaptive radiation of *Dendrosenecio* (Asteraceae) Which pattern?

1. Inter-island dispersal followed by elevation shifts
2. Multiple dispersals from similar elevations



8 species adapted to 4 life zones (in color)

Mt. Kenya

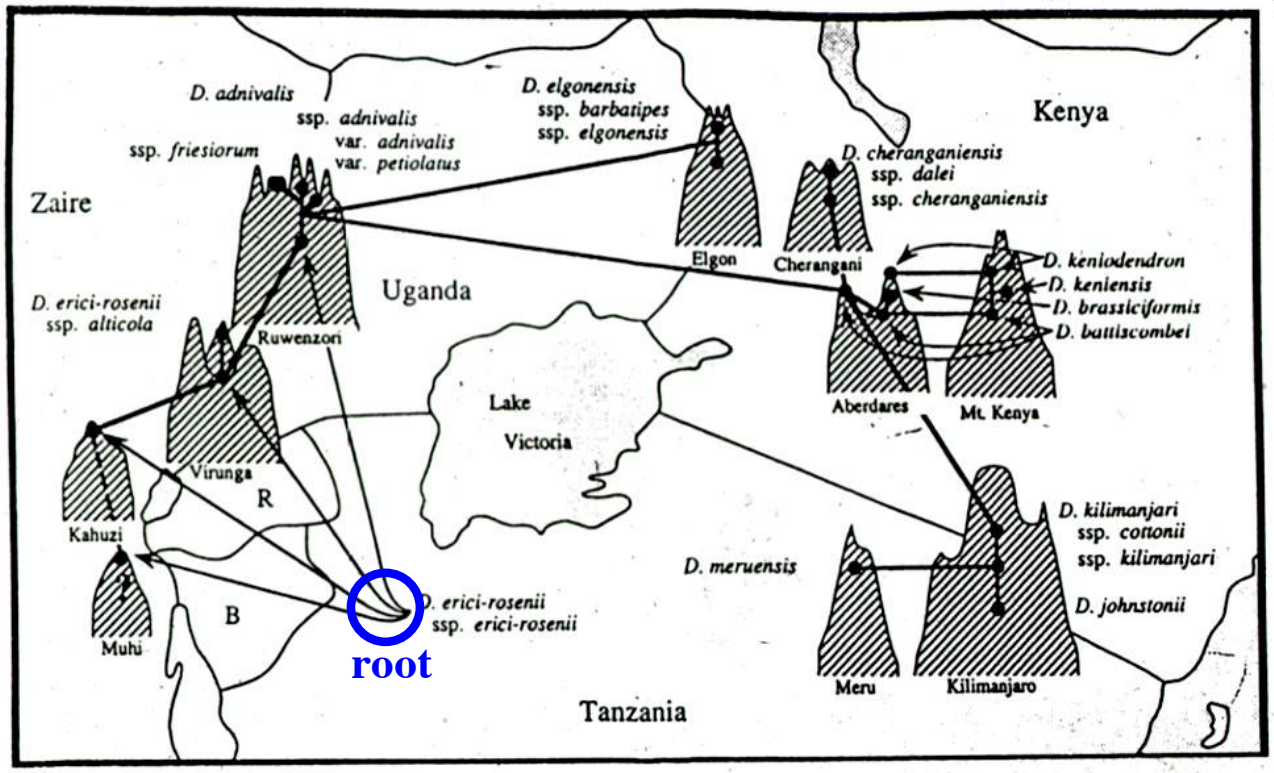
Eric Knox

‘Islands in the Sky’ - Paramo, Afroalpine

- Biogeography of afroalpine flora – adaptive radiation of *Dendrosenecio* (Asteraceae) Which pattern?

1. Inter-island dispersal followed by elevation shifts
2. Multiple dispersals from similar elevations

- Convergence of species adapted to similar elevations!



Phylogeny superimposed on biogeography

Mt. Kenya