

Biogeography of the Canary Islands

Fredrik Ronquist

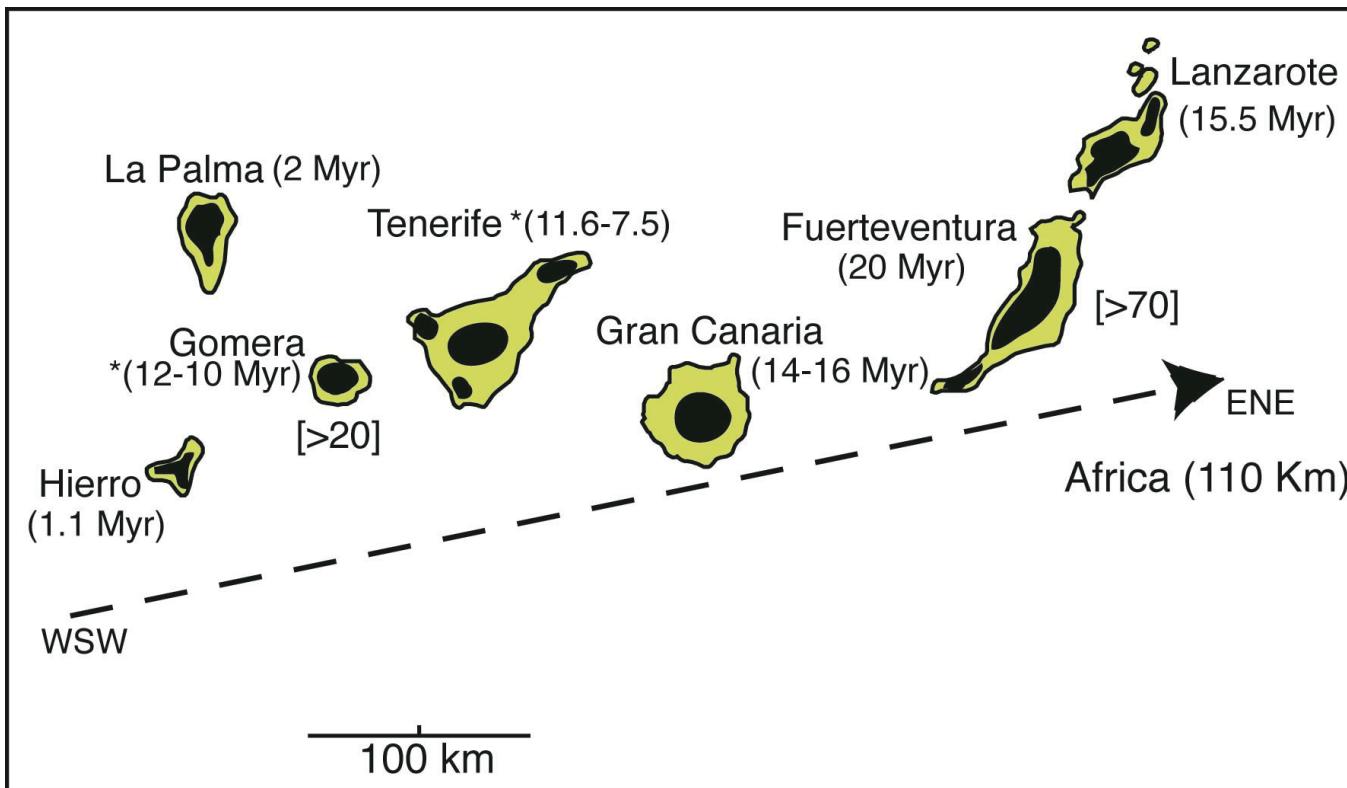
Swedish Museum of Natural History, Stockholm,
Sweden

Isabel Sanmartín

Real Jardín Botánico, Madrid, Spain



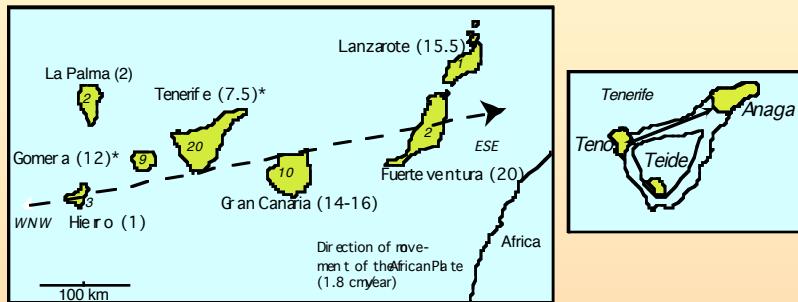
The Canary Islands



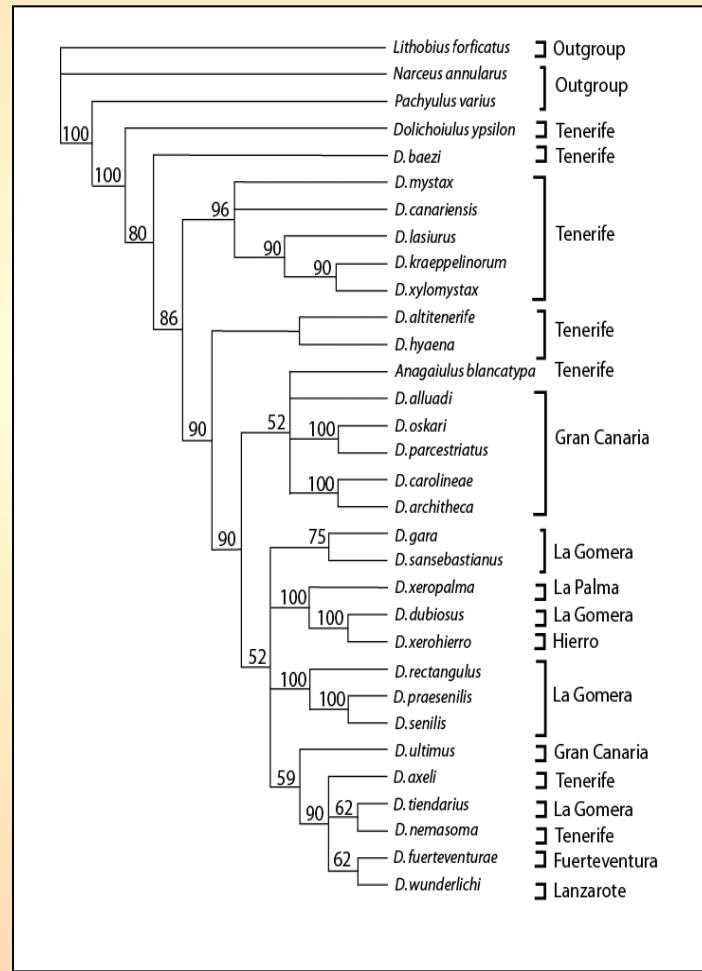
Dolichoiulus (Diplopoda)



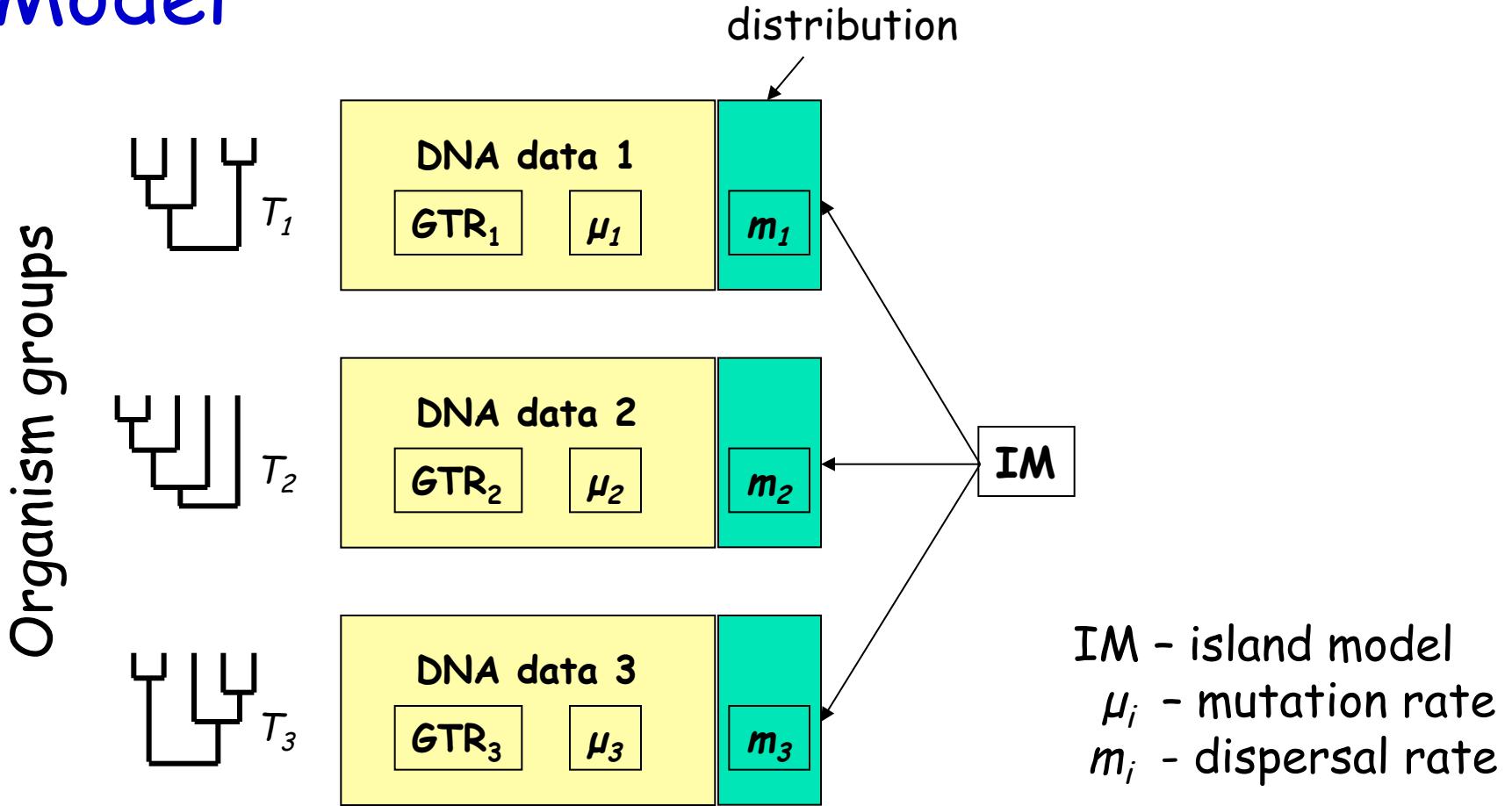
***Dolichoiulus* (Diplopoda, Julida, Julidae, Pachyulinae)**



46 endemic species



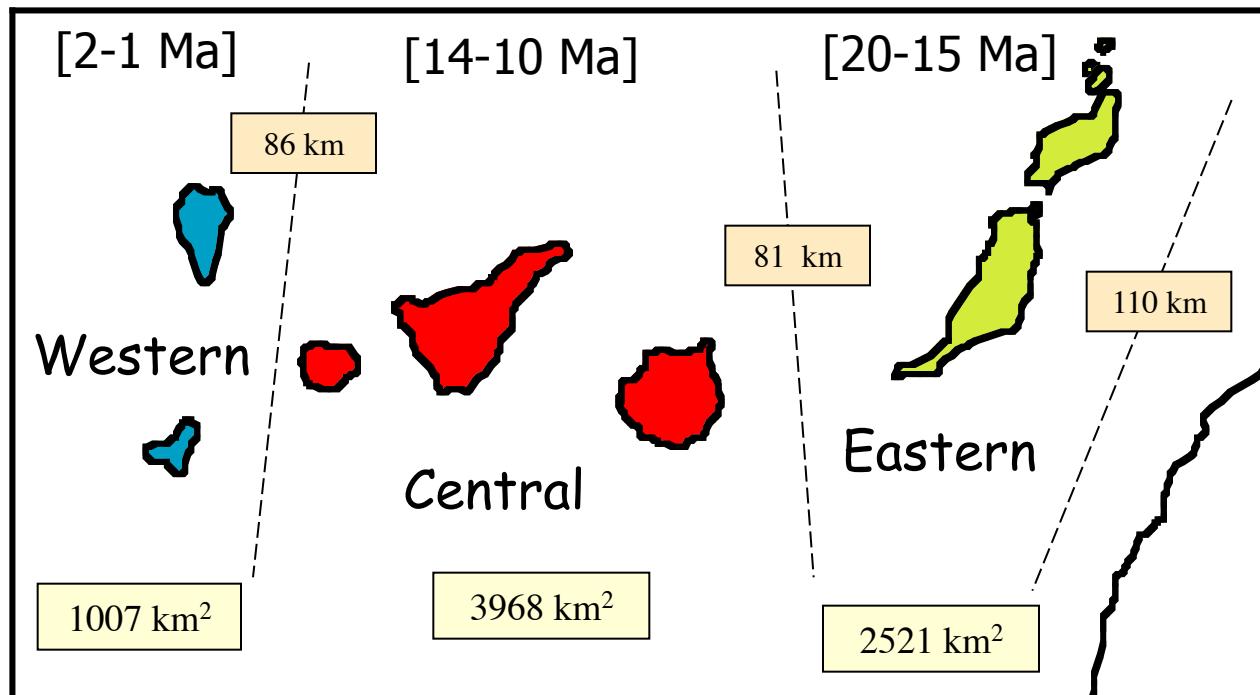
Model



Inference

Bayesian inference using MCMC sampling,
accommodating uncertainty in all model parameters

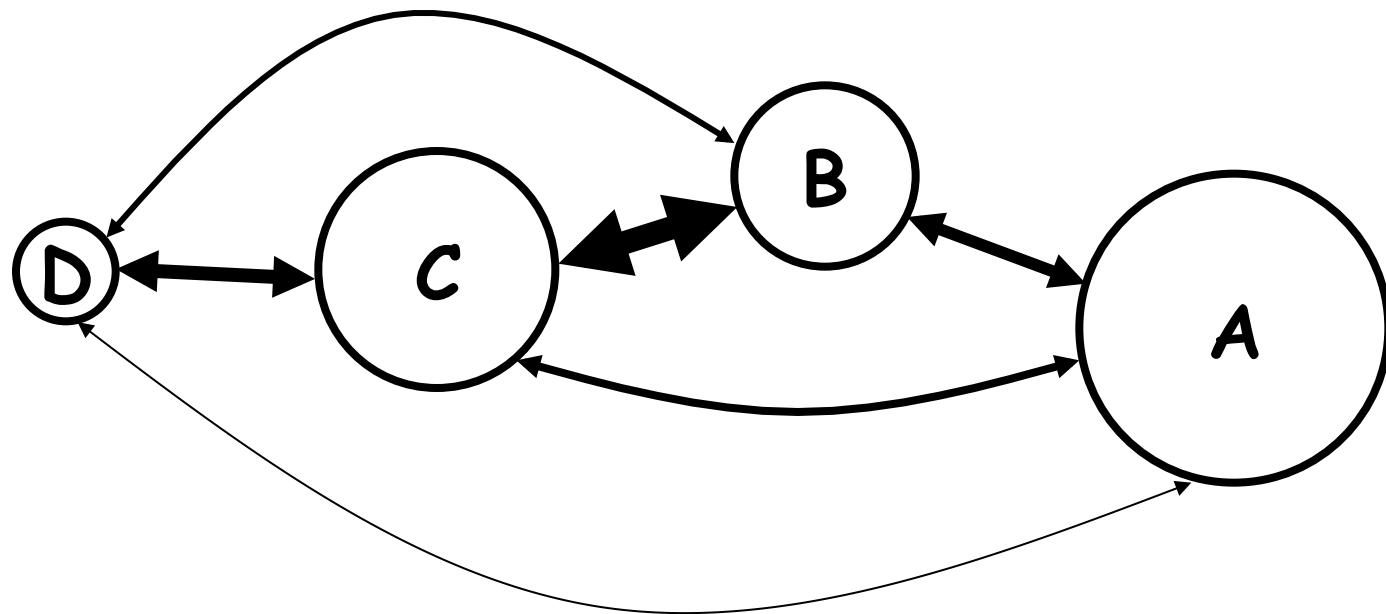
Canary Islands: 3-island model



Mainland

Island "GTR" model

Time reversible continuous time Markov chain



Differing relative carrying capacities of islands
Differing intensities of biotic exchange between islands

Instantaneous rate matrix

to
from

$$Q = \begin{pmatrix} & [A] & [B] & [C] & [D] \\ [A] & - & \pi_B r_{AB} & \pi_C r_{AC} & \pi_D r_{AD} \\ [B] & \pi_A r_{AB} & - & \pi_C r_{BC} & \pi_D r_{BD} \\ [C] & \pi_A r_{AC} & \pi_B r_{BC} & - & \pi_D r_{CD} \\ [D] & \pi_A r_{AD} & \pi_B r_{BD} & \pi_C r_{CD} & - \end{pmatrix}$$

π_i Relative carrying capacity of island i

r_{ij} Relative dispersal rate between islands i and j



Laura Martinez

Canary Island flora

15 groups, 567 lineages



Javier Fuertes





Raquel Martin

Canary Island fauna

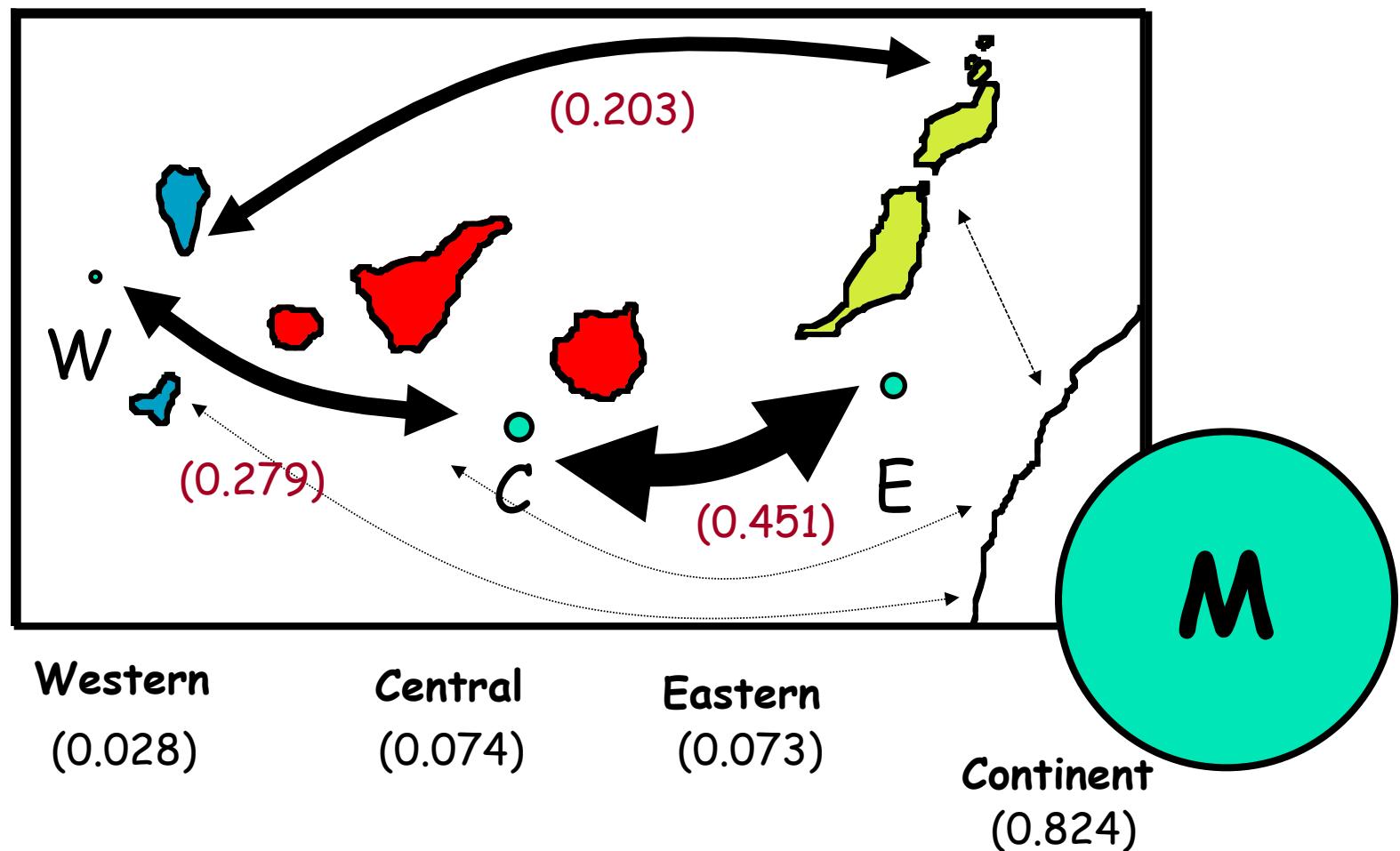
19 groups, 578 lineages



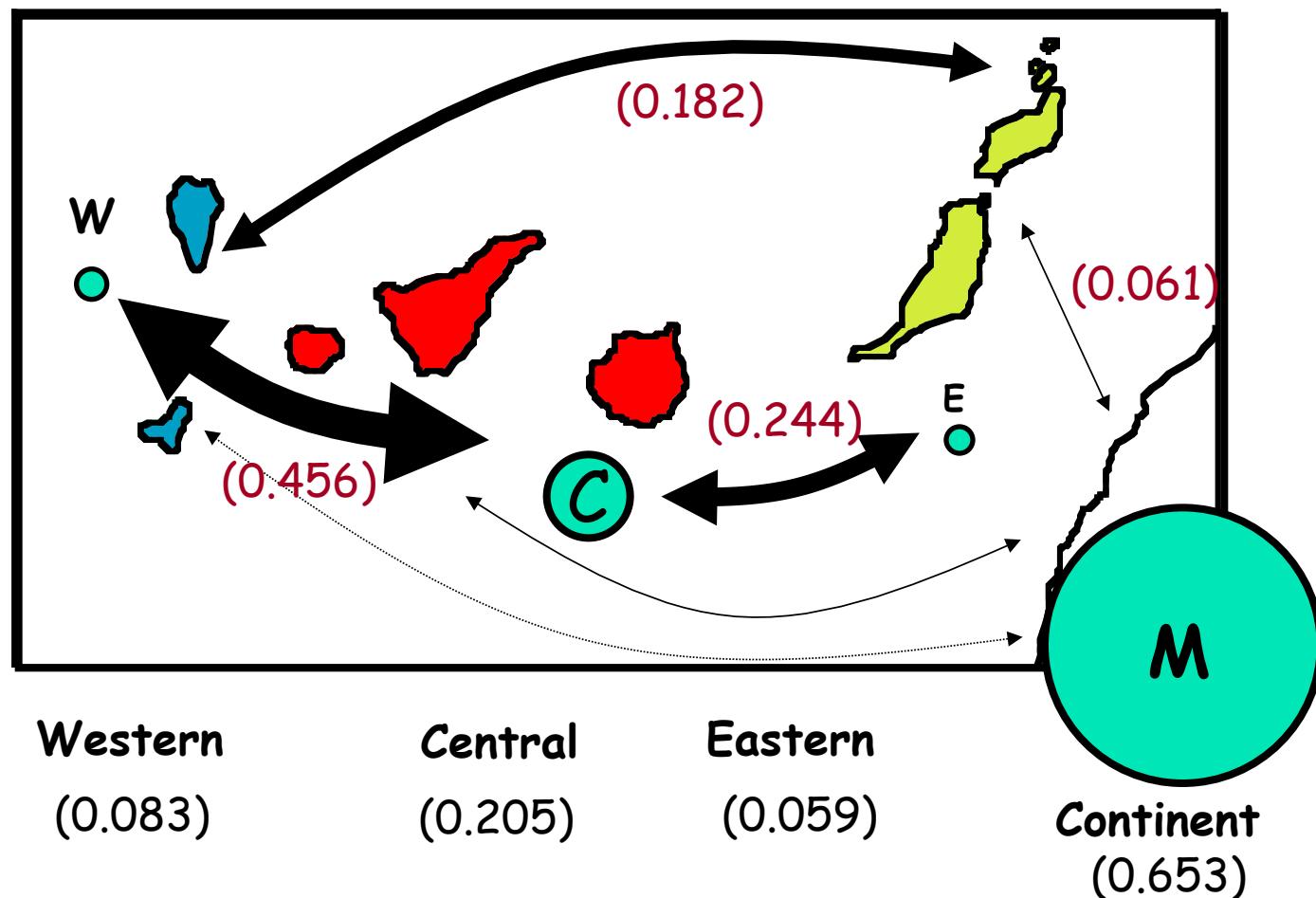
Javier Fuertes



Colonization patterns (plants)



Colonization patterns (animals)

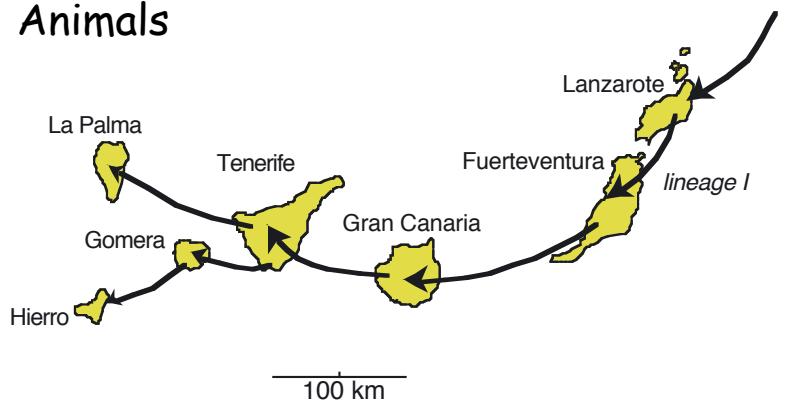


Hypotheses to test

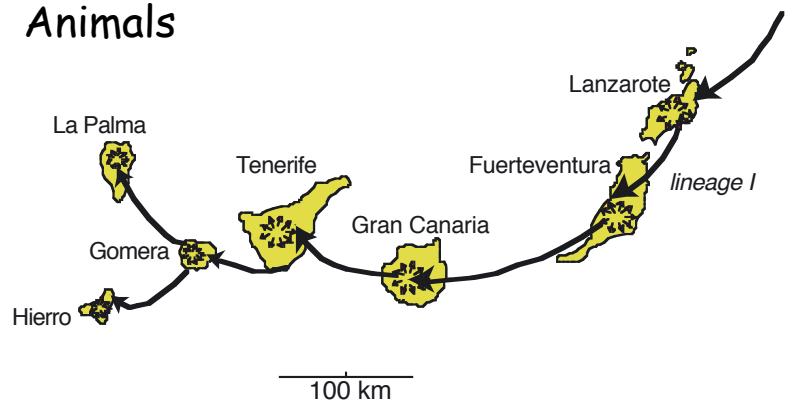
- Plants shift between islands more readily than between habitats. For animals, it is the reverse. They tend to radiate into different niches on the same island rather than shifting between islands. Is this correct? If so, how large is the difference?
- The carrying capacities of islands is partly determined by the area of the island, and partly by other factors, such as geological events and altitudinal and ecological diversity. What is the magnitude of these non-area effects on each island?
- Similarly, the biotic exchange between islands is partly determined by distance and partly by other factors, such as wind and sea currents etc. What is the magnitude of these non-distance effects on the biotic exchange between each pair of islands?

Colonization models

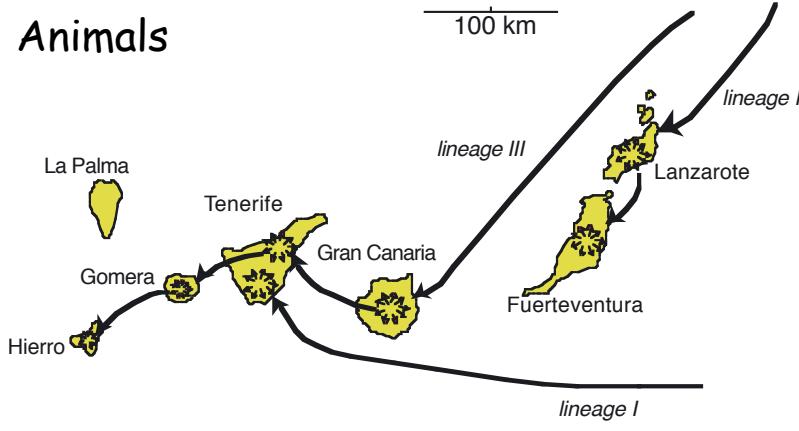
Animals



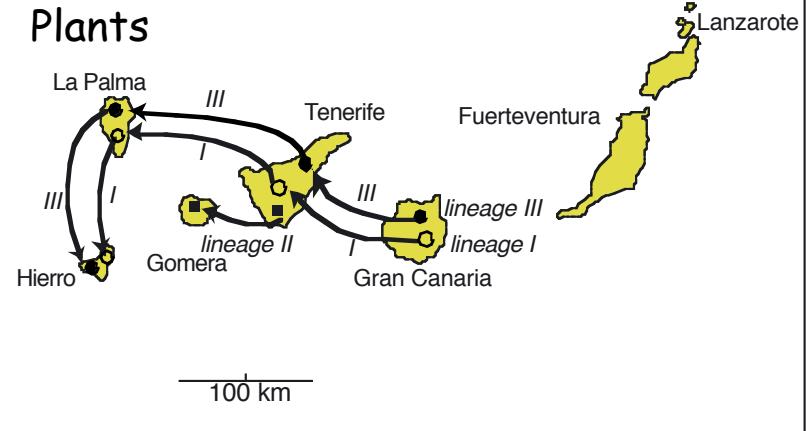
Animals



Animals



Plants



Within-island diversification
Niche evolution

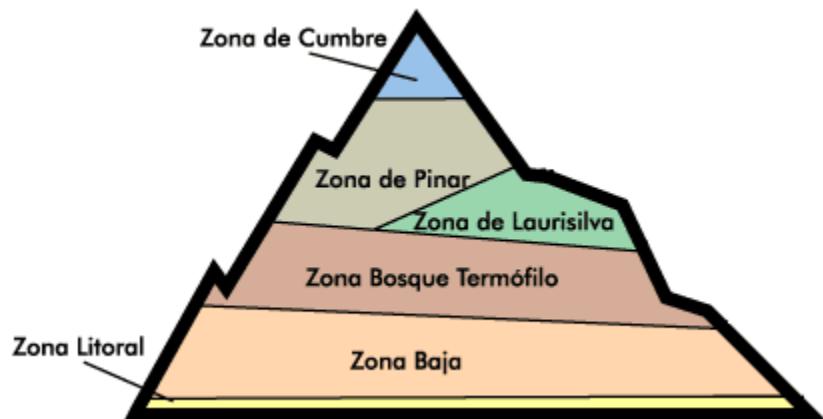
Inter-island colonization of
similar biomes (niche conservatism)



I move, you change

Ecological zones

- Coastal belt
- Open habitat
- Thermophilous forest
- Laurisilva
- Pine forest
- Sub-alpine



Ten island-habitat types

- | | |
|----|---------------------------|
| M1 | Other Mainland |
| E2 | Eastern-Open |
| C2 | Central-Open |
| W2 | Western Open |
| C3 | Central-laurel forest |
| W3 | Western-laurel forest |
| C4 | Central-pine forest |
| W4 | Western-pine forest |
| C5 | Central-alpine vegetation |
| W5 | Western-alpine vegetation |

Separating area and ecology contributions to carrying capacity

a, e Area and ecology components

$\beta a + (1-\beta)e$ Linear mix

$a^\beta e^{(1-\beta)}$ Power mix

$$S = c A^z \quad z = 0.25 \quad (0.22, 0.28)$$

Standard model:

`pi ~ dirichlet(1, 1, 1, ...)`

Mixture-of-effects model:

```
areaK <- simplex( <eqn>, <eqn>, ...)
```

```
ecoK ~ dirichlet( 1, 1, ...)
```

```
prop ~ dirichlet( 1, 1 )
```

```
pi := powermix( areaK, ecoK, prop )
```