The Simulation Model
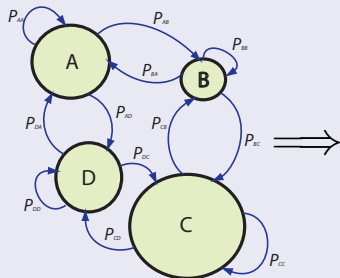
The Birth-Death Process

- Probability of speciation, birth rate $= \lambda$
- Probability of extinction, death rate $= \mu$
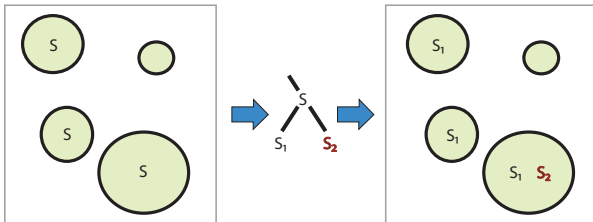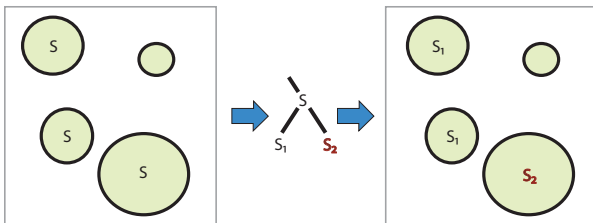
The Geographical Template

	A	B	C	D
A	P_{AA}	P_{AB}	P_{AC}	P_{AD}
B	P_{BA}	P_{BB}	P_{BC}	P_{BD}
C	P_{CA}	P_{CB}	P_{CC}	P_{CD}
D	P_{DA}	P_{DB}	P_{DC}	P_{DD}

Speciation Modes

- Sympatric

- Allopatric

Simulation Set Up

- Set model parameters:
  - Birth (speciation) rate, λ
  - Death (extinction) rate, μ
  - Geographic template.
  - Speciation mode.
- Set termination condition:
  - Target diversity: run until total number of species $= T$.
  - Number of generations: run until number of generations $= G$.
- Specify random number seed.

Simulation Procedure

1. Initialize: introduce single lineage into a region.
2. Repeat until T species or G generations, or all species extinct:
   - Migration:
     - For each species in each region, select a destination region for dispersal (including current region, i.e., no dispersal) according to dispersal probability.
     - Add species to destination region if not already present.
   - Diversification:
     - For each species in the system, draw a uniform random number, $u \sim U(0, 1)$.
     - If $u < \lambda$: split lineage.
     - If $u > \lambda$ and $u < (\lambda + \mu)$: remove lineage.
3. Report results.

Simulation Output

- Incidence (presence/absence) matrix.
- Phylogeny.
- Summary of total number of lineages and total number of endemic lineages in each region.
- Classification tree of areas based on shared species.