

The comparative biogeography of Philippine geckos challenges predictions from a paradigm of climate-driven vicariant diversification across an island archipelago

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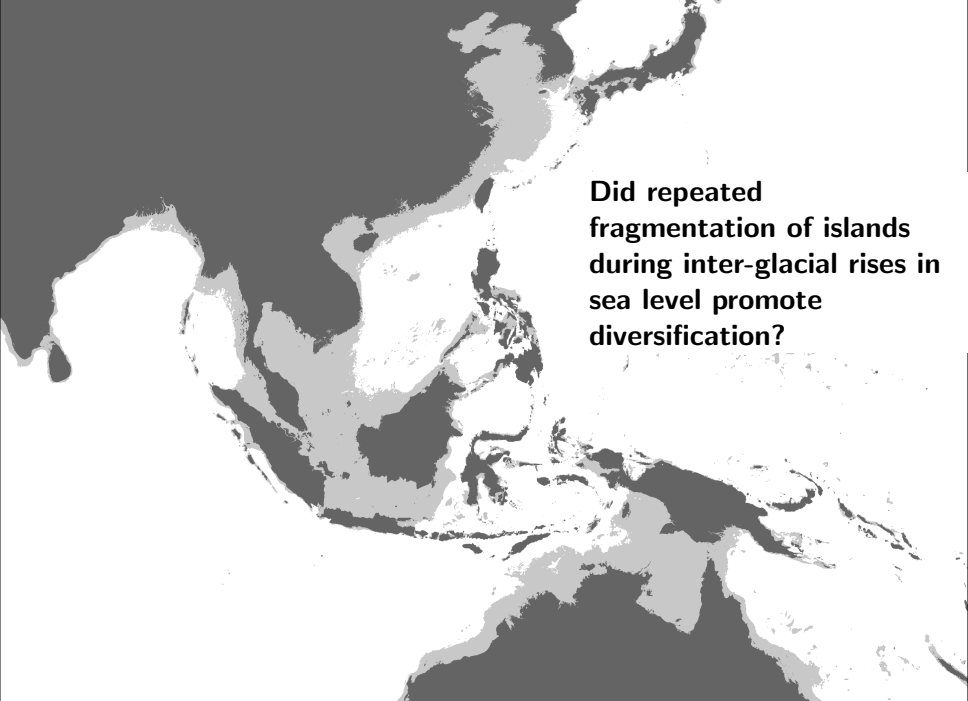
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³Biodiversity Institute and Department of Ecology and Evolutionary Biology, University of
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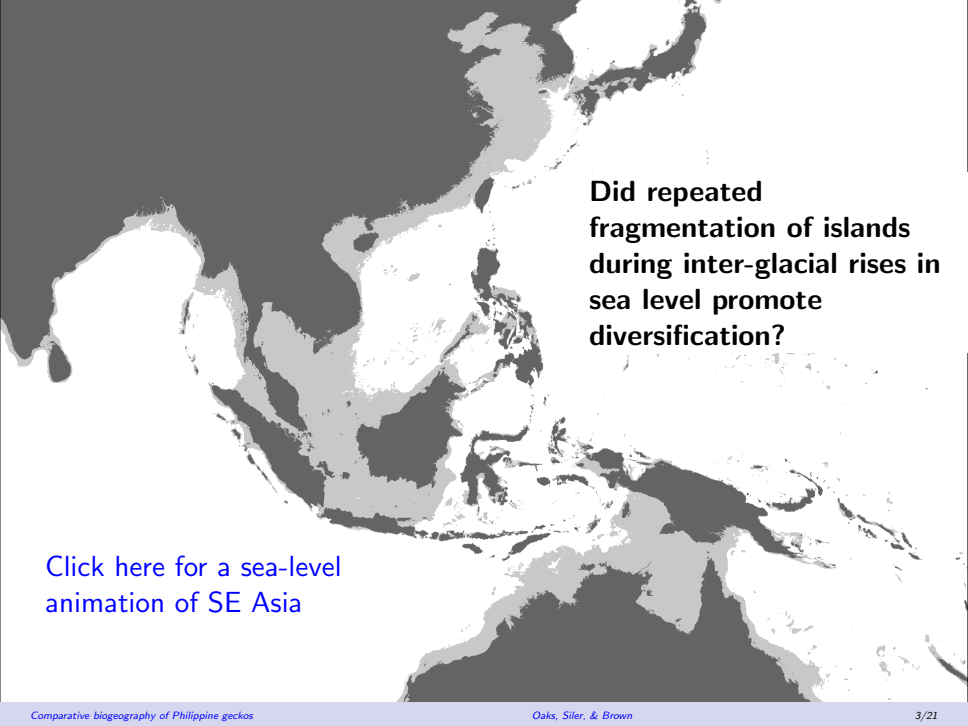
April 19, 2019







**Did repeated
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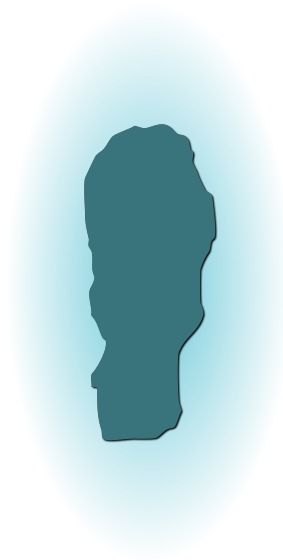
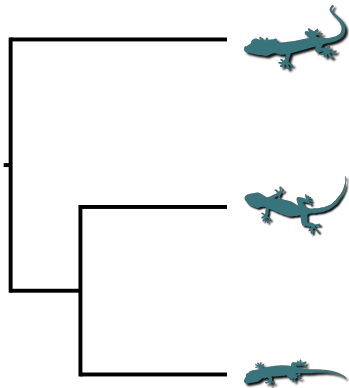
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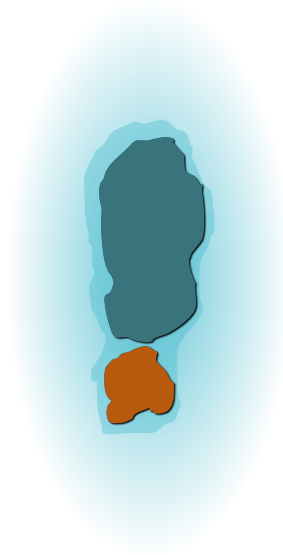
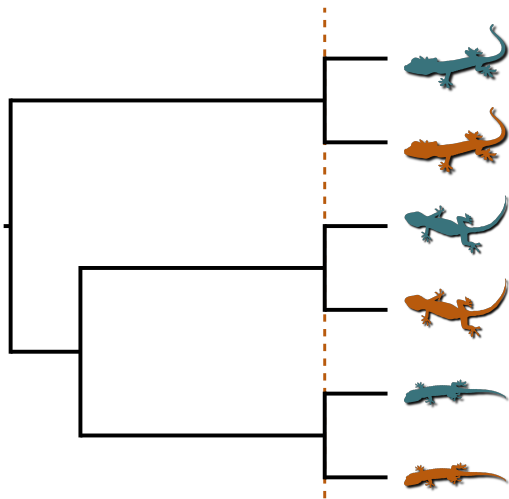
[Click here for a sea-level
animation of SE Asia](#)

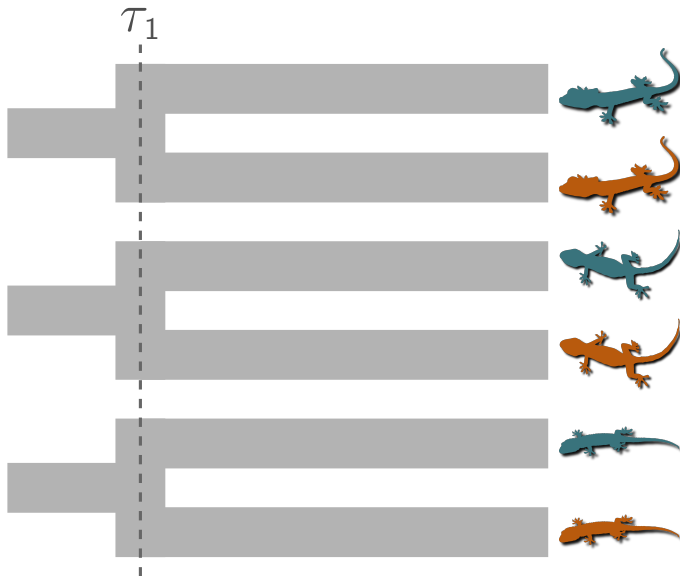
“Species-pump” Hypothesis Repeated climate-driven fragmentation of the Philippine Islands was a primary mechanism of speciation for terrestrial fauna

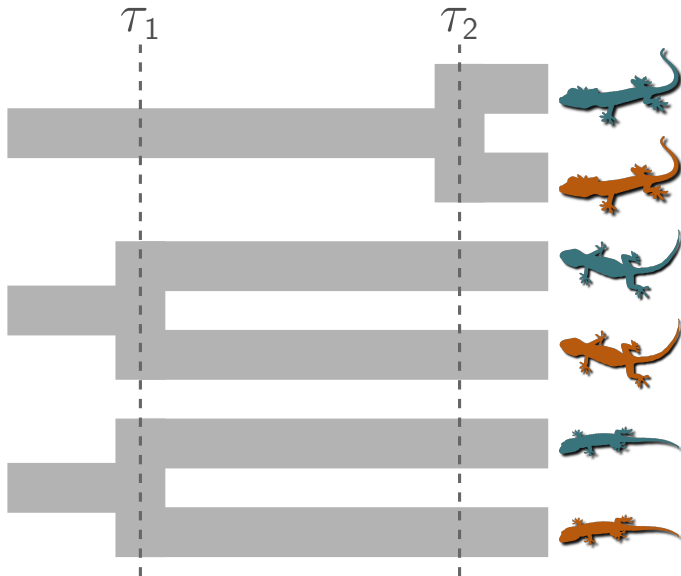
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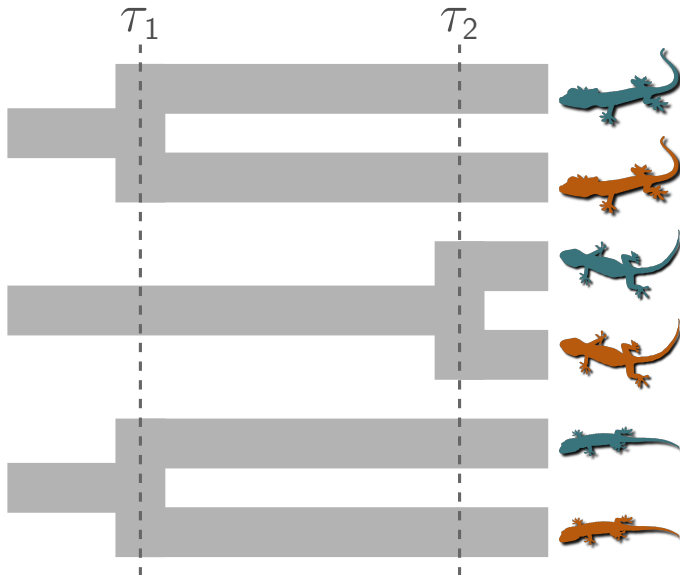
Prediction Taxa co-distributed across islands within the same Pleistocene aggregate island complex (PAIC) will have divergence times that tend to be clustered around times when sea levels fragmented the islands

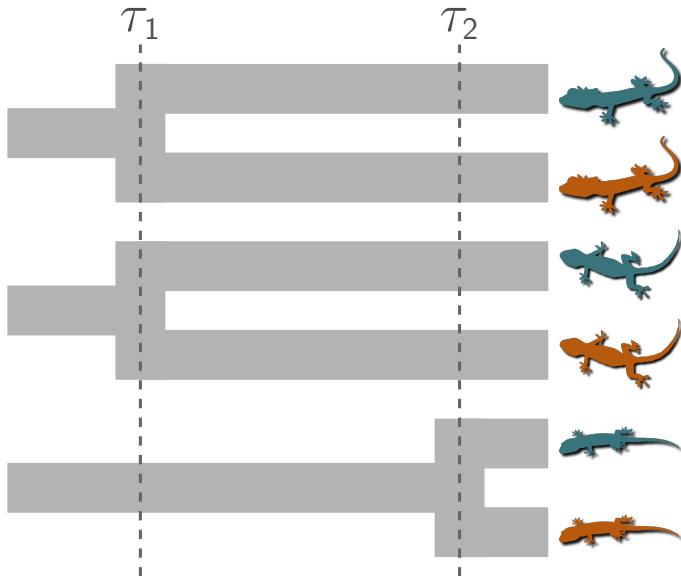


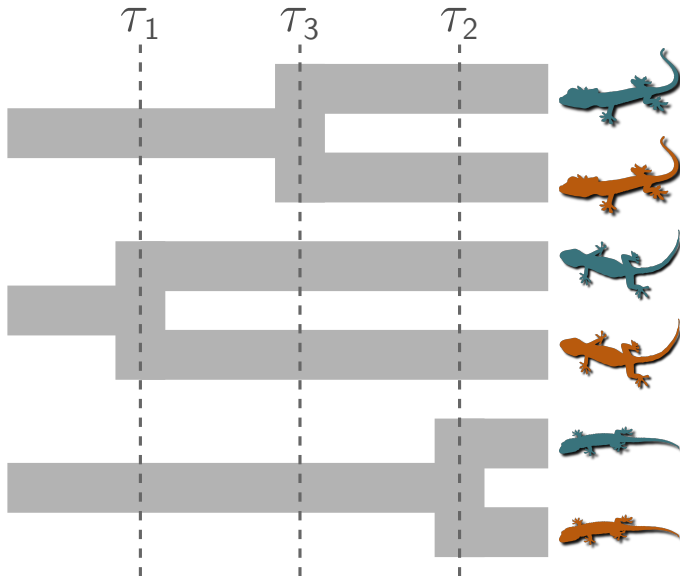


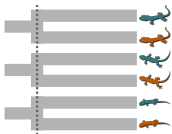
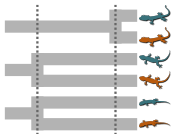
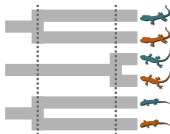
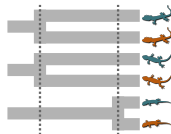
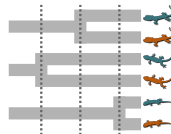


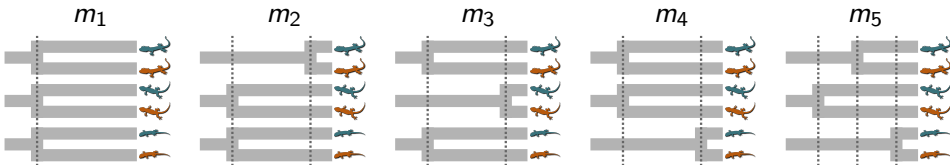








m_1  m_2  m_3  m_4  m_5 



We want to infer the model and divergence times given genetic data

Previous tests of “species-pump”

- ▶ Oaks et al. (2013)¹ collected mitochondrial DNA sequences from 22 pairs of populations (including bats, shrews, skinks, geckos, snakes, and frogs)

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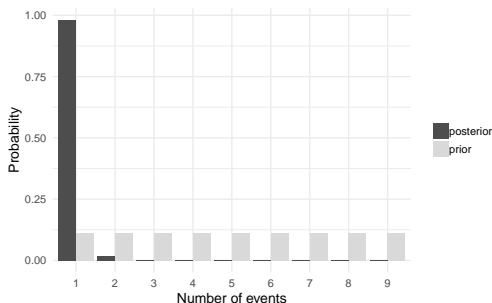
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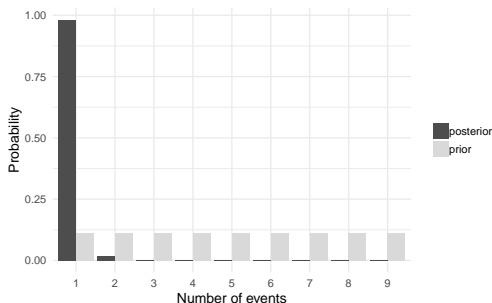
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 - ▶ But, method was very sensitive to prior assumptions and often biased toward estimating co-divergences



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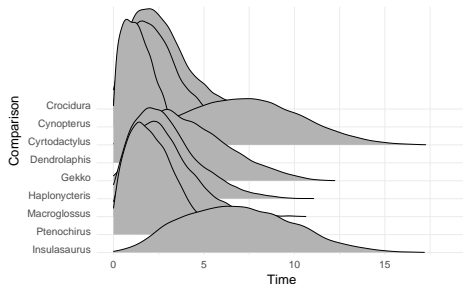
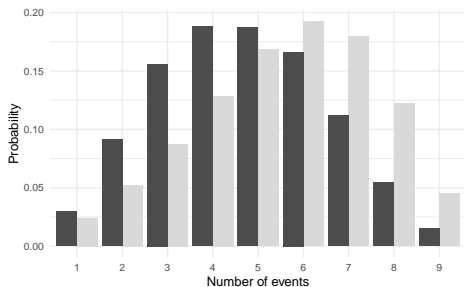
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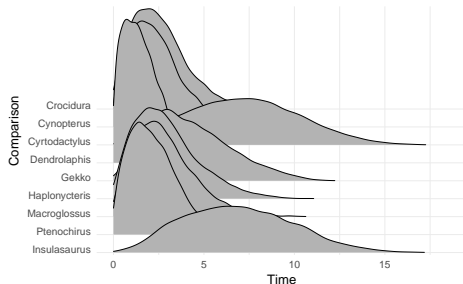
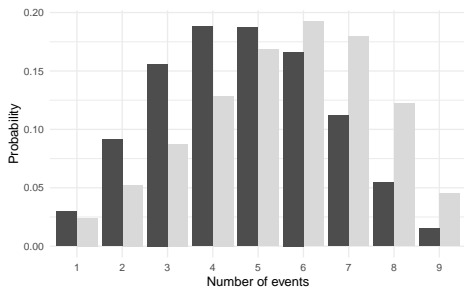
- ▶ Oaks (2014)¹ reanalyzed the data from Oaks et al. (2013)² with a modified ABC method dpp-msbayes
 - ▶ New method was less biased, but little information in summary statistics to inform divergence times



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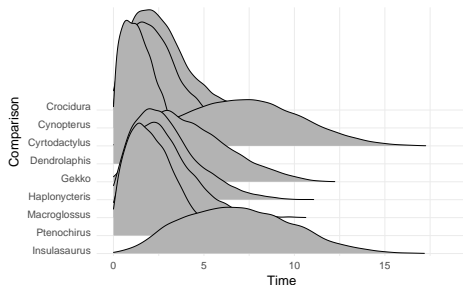
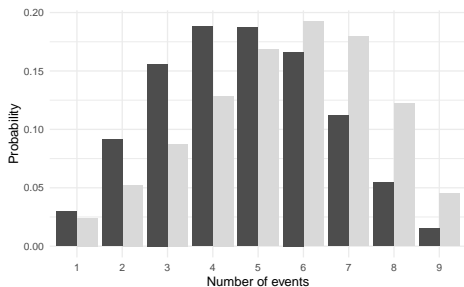


What now? We need **more data** and/or an **improved method** that better utilizes the information in those data.

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What now? We need **more data** and/or an **improved method** that better utilizes the information in those data. **Our goal is to do both.**

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Cyrtodactylus (Gekkonidae)

- ▶ 265+ species across Asia
- ▶ 10+ species across Philippines
- ▶ Nocturnal, scansorial lizards that eat terrestrial invertebrates
- ▶ Specialized bent toes for climbing

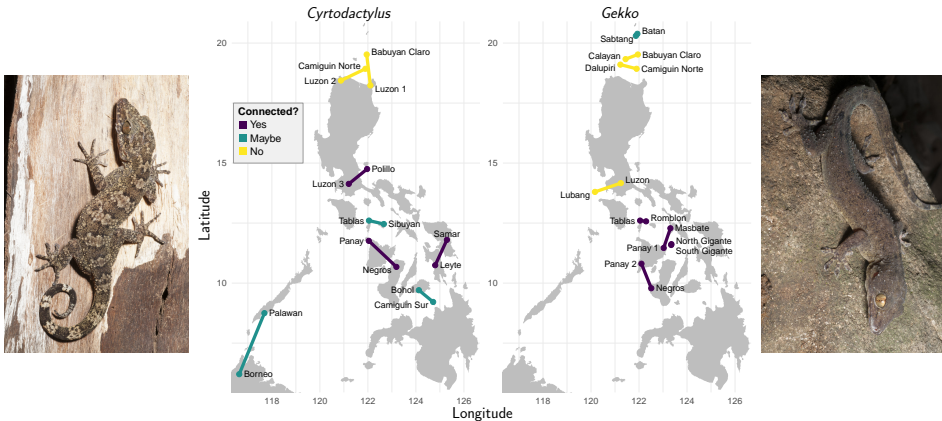


Gekko (Gekkonidae)

- ▶ 60+ species across Southeast Asia
- ▶ 14+ species across Philippines
- ▶ Nocturnal, scansorial lizards that eat terrestrial invertebrates
- ▶ Subdigital lamellae for climbing



Methods



- ▶ Sampled individuals from 8 pairs of populations for both *Cyrtodactylus* and *Gekko*
 - ▶ Sampled 2–5 individuals per population
- ▶ Collected genome-wide DNA sequence data from each individual
 - ▶ Restriction-site-associated DNA sequencing (RADseq)

Analyzed RADseq data with full-likelihood Bayesian comparative phylogeographic method:

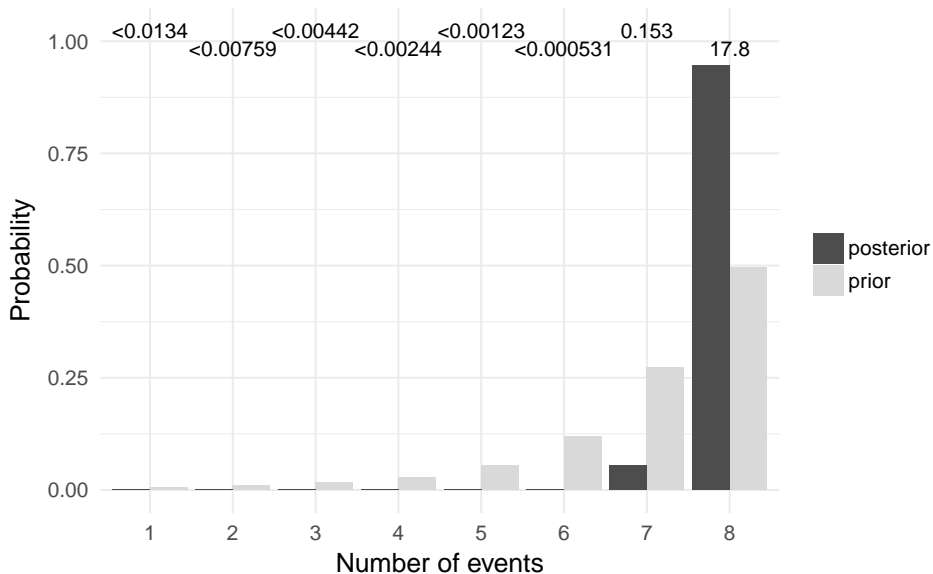
Ecoevolity: Estimating evolutionary coevality

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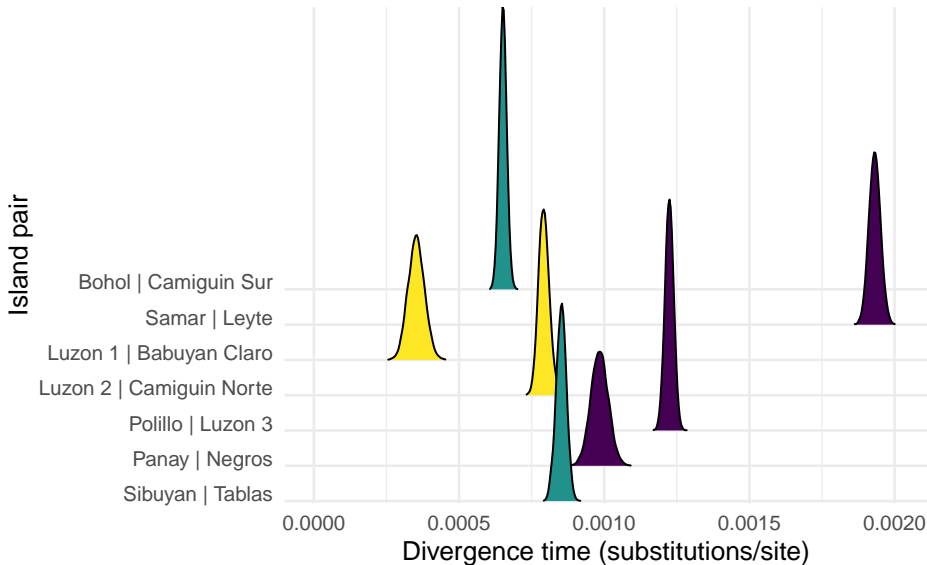
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- ▶ Used simulations to assess how well ecoevolity works given the gekkonid RADseq data sets

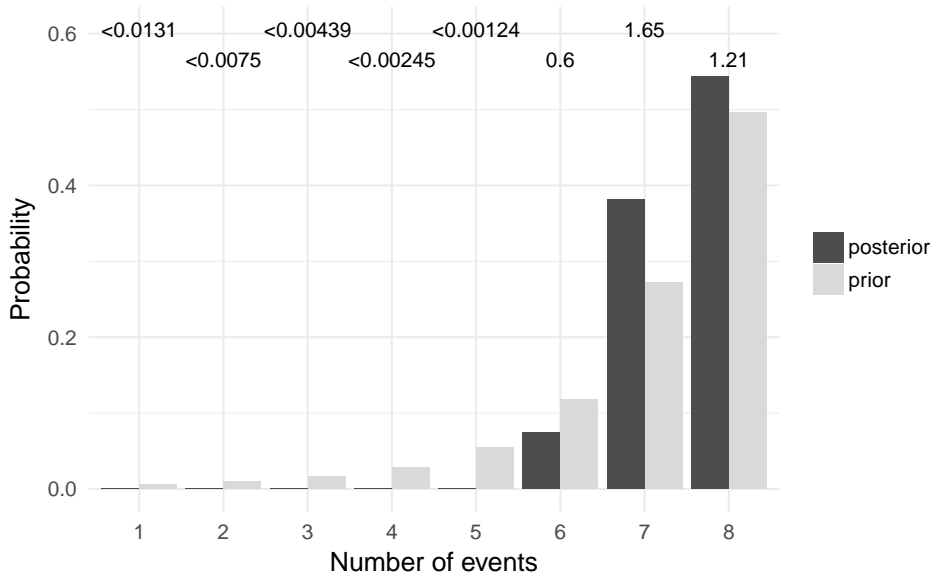
Results: *Cyrtodactylus*



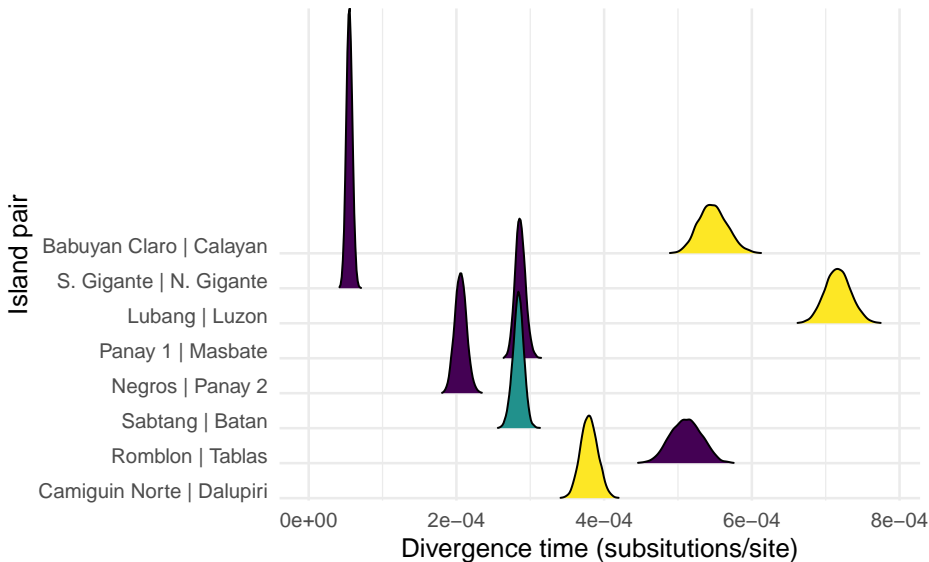
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Results: *Gekko*



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Key findings

- ▶ Strong support that all 8 pairs of *Cyrtodactylus* populations diverged independently

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Key findings

- ▶ Strong support that all 8 pairs of *Cyrtodactylus* populations diverged independently
- ▶ Weak support that all 8 pairs of *Gekko* populations diverged independently
- ▶ Simulation results suggest *ecoevolity* can accurately estimate the timing and number of divergences given the gekkonid RADseq data

Caveats

- ▶ Too few island pairs to rule out climate-driven vicariant speciation
- ▶ Differences in divergence times could be due to variation in fragmentation times among island pairs
- ▶ Differences in divergence could also be due to variation in mutation rates

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- ▶ Differences in divergence times could be due to variation in fragmentation times among island pairs
- ▶ Differences in divergence could also be due to variation in mutation rates

- ▶ Seems safe to conclude that the “species-pump” is not the rule for gekkonids, but maybe the exception

Take home points

- ▶ Support against the “species-pump” hypothesis

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- ▶ Results suggest repeated cycles of climate-driven island fragmentation were not an important mechanism of speciation for gekkonid lizards in the Philippines

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- ▶ Support against the “species-pump” hypothesis
- ▶ Results suggest repeated cycles of climate-driven island fragmentation were not an important mechanism of speciation for gekkonid lizards in the Philippines
- ▶ Rare over-water dispersal via rafting on vegetation is likely an important mechanism responsible for the distribution of gekkonid lizards in the Philippines

Everything is on GitHub...

Software:

- ▶ Ecoevolity: <https://github.com/phyletica/ecoevolity>

Open-Science Notebook:

- ▶ Gecko RADseq: <https://github.com/phyletica/gekgo>

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Computation:

- ▶ Alabama Supercomputer Authority
- ▶ Auburn University Hopper Cluster

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Photo credits:

- ▶ Rafe Brown and Cam Siler
- ▶ [PhyloPic!](#)

Questions?

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