New Ways to Gain More

A Case in Pleurodonta

# Reliable Insights Into Adaptive Radiations

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Photo: L. Alencar

## Background

- SSE models are popular tools to study adaptive radiations but can be misled (Rabosky & Goldberg 2015).
- Hidden states (HiSSE; Beaulieu & O'Meara, 2016) detect confounding factors to rate heterogeneity.
- Adequacy tests (adequaSSE; Schwery, Freyman & Goldberg, *in prep*.) can detect mismatches between data and model due to other processes.
- "Phylogenetic Natural History" approach (Uyeda, Zenil-Ferguson & Pennell, 2018) combines hypothesis-testing and data-driven approaches to disentangle the impact of observed and latent factors.

Can the combination of **hidden states** and **adequacy tests** help track spurious associations of traits and diversification?

## Methods I

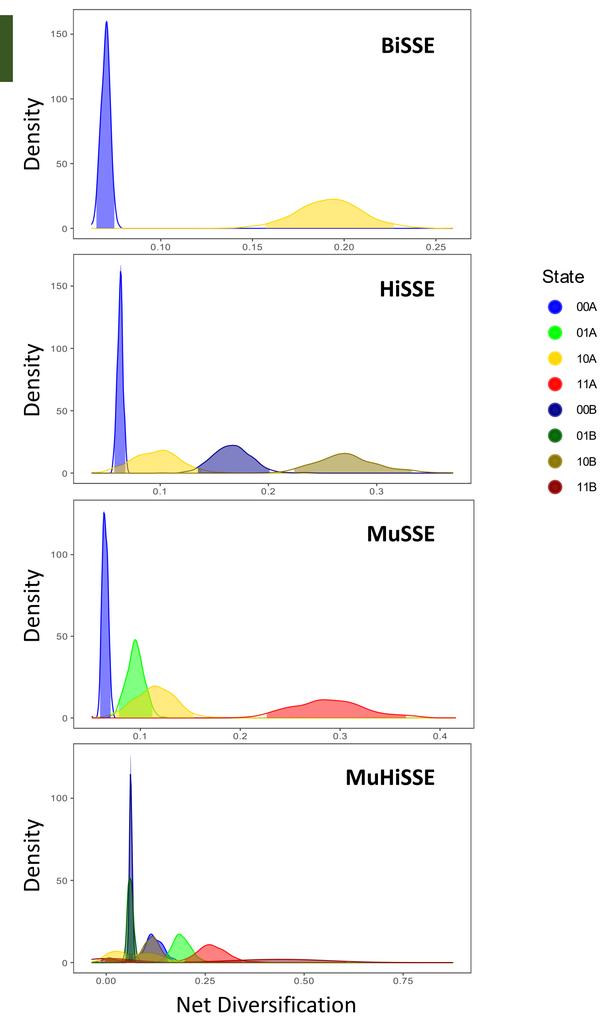
**Dated phylogeny:**
- 733 out of 1111 species of Pleurodonta
- Based on trees by Tonini *et al.* (2016)

**Data:**
- Reproductive mode (oviparous/viviparous)
- Occurrence in Andean mountains.

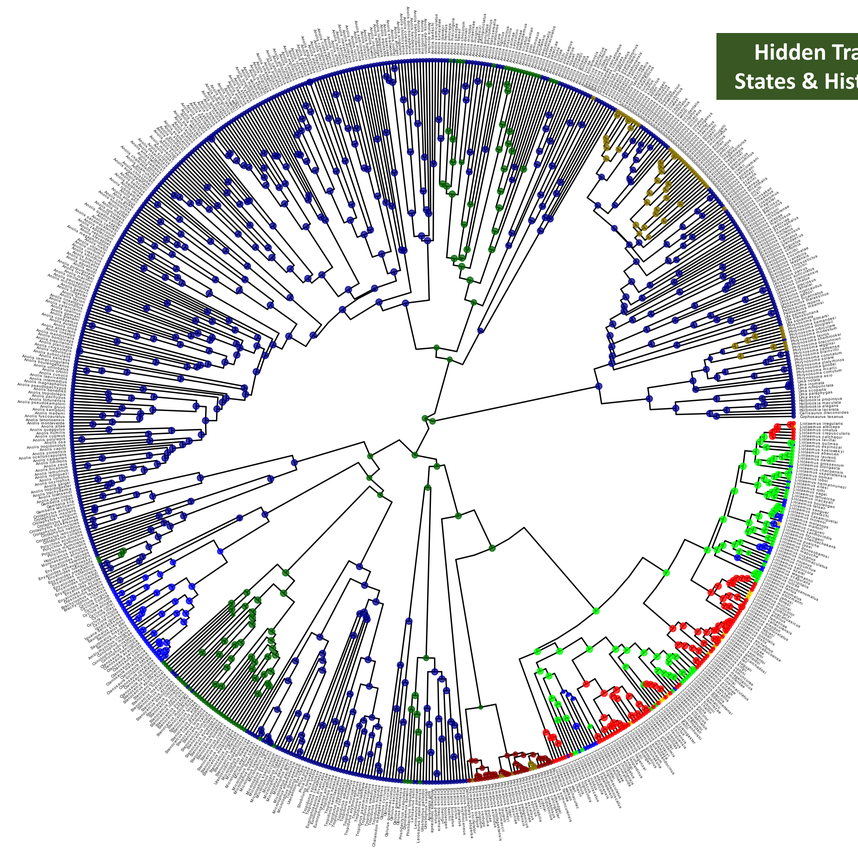
**Diversification Models:**
- BiSSE/MuSSE & HiSSE/MuHiSSE in RevBayes.

**Model Adequacy:**
- Simulate posterior predictive data sets
- 4 different conditionings
- Calculate large number of summary statistics on empirical and simulated data

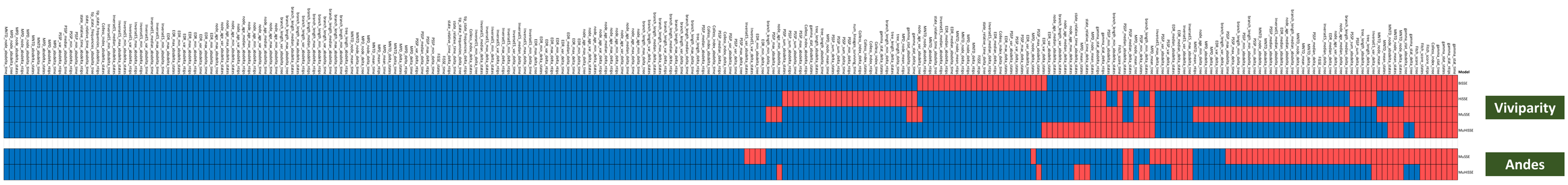
SSE Rate Estimates




Hidden Trait States & History



**Model adequacy** tests can pinpoint areas where models fall short!

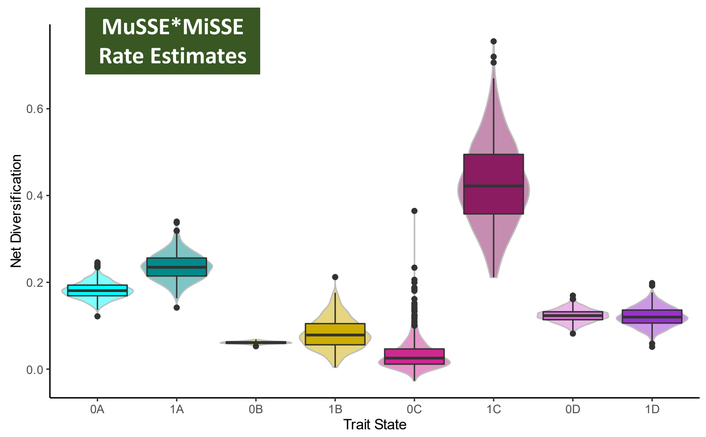



How much of the **rate heterogeneity** in the data can really be **explained by the focal trait**?

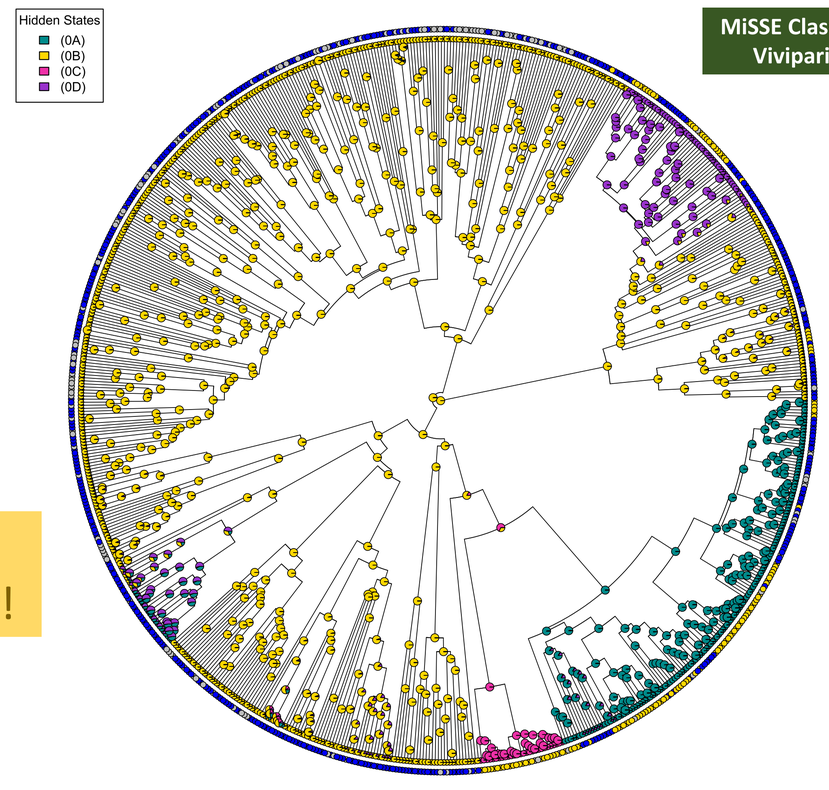
## Methods II

**Phylogenetic Natural History:**
- MiSSE in R (~HiSSE with hidden states only)
- Best number of states based on AIC
- MuSSE with combined MiSSE-states & trait

MuSSE*MiSSE Rate Estimates




Viviparity seems to have little to **no additional explanatory power**!

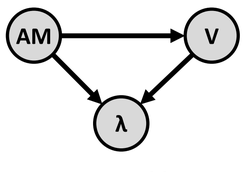



MiSSE Classes & Viviparity

## Future Directions

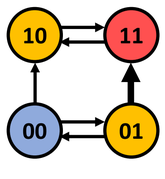
- Causal scenarios on the effect of traits on diversification e.g., where true cause both affects rates and focal trait
- Implement in SSE framework
- Rule out unsupported scenarios

Causal Scenario




2 Causes, Additive

SSE-Implementation




AM = Andean Mnts, V = Viviparity, λ = div. rates

1X = Viviparous, X1 = Andean Mnts.
→ = trait state transition, Colours: div. rates

Photo: Marcio Borges-Martins

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### References

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