How macroecology affects macroevolution: the interplay between extinction intensity and trait-dependent extinction in brachiopods.

Taxon occurrence as a function of both emergent biological traits and environmental context

Other projects

Moving forward

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History

- presented at GSA 2015
- rejected from *Evolution*
  - encouraged resubmit
  - audience issues
  - difficult and transformative reviews
  - resubmitted 3 March

New measure of taxon's environmental affinity

Probability of observing (# epicontinental / total # occurrences) given Beta(α, β).

α is the # epicontinental background occurrences ($+ 1$).

β is the # open ocean background ($+ 1$).

Measure of sampling and imputed values

Sampling is measured as the gap statistic r:
(number of bins with an occurrence - 2) / (duration in bins)

Can only be estimated for taxa with duration of three or more.
Have to impute (e.g. fill-in) the values for all other taxa r^*.

$$r \sim \text{Beta}(\phi, \lambda)$$
$$\phi = \text{logit}^{-1}(W\gamma)$$
$$r^* \sim \text{Beta}(\phi^*, \lambda)$$
$$\phi^* = \text{logit}^{-1}(W^*\gamma)$$

Note: Beta distribution parameterized in terms of mean ϕ and total count λ.
Also, this presentation excludes final (hyper)priors.

Theoretical underpinning

- changes in demographic structure of regional species pool
- intersection of macroecology and macroevolution
- fourth-corner type problem

individual-level
(genus i at time unit t)

- log-odds of occurrence
  probability at time t
- effect of locomotor type
  - arboreal, digitigrade,
    plantigrade, unguligrade,
    fossorial, scansorial
- effect of dietary type
  - carnivore, herbivore,
    insectivore, omnivore
- body size
  (rescaled log body mass)

group-level (2 My time unit t)

- overall mean of log-odds of
  occurrence probability
- temperature record based on
  Mg/Ca estimates
  - mean and interquartile
    range of rescaled value
- plant community phase
  following Graham

Model of taxon occurrence

- response is p/a of genus in NA at time t
  - Bernoulli variable
  - probability is (observation prob) times ("true" presence)
- observation probability is effect of sampling/fossil record
- the latent discrete "true" presence modeled as a multi-level logistic regression
  - individual- and group-level

$$y_{i,t} \sim \text{Bernoulli}(\rho_t z_{i,t})$$

$$\text{logit}(\rho_t) \sim \mathcal{N}(\rho^{'}, \sigma_\rho)$$

$$z_{i,t} \sim \text{Bernoulli}(\theta_{i,t})$$

$$\text{logit}(\theta_{i,t}) = z_{i,t-1}(\alpha_t + X_i\beta_t) + (\prod_{k=1}^{t-1} 1 - z_{i,k})(\alpha_t + X_i\beta_t)$$

$$\beta_{d,t} \sim \mathcal{N}(\mu_d, \sigma_d)$$

$$\alpha_t \sim \mathcal{N}(\mu + \phi_{p[t]} + U_t\gamma, \sigma_\mu)$$

$$\phi_p \sim \mathcal{N}(0, \sigma_\phi)$$

Note: My implementation in Stan marginalizes over all possible (range-through) values of z instead of estimating the discrete parameters, and also uses a noncentered parameterizations of the hierarchical effects for better posterior sampling behavior. Also, this presentation excludes final (hyper)priors.

- simulate fossil record given only $y_{\_t=1}$, all its covariates, and θ
  - where θ is the set of all parameters
- leave-one-out cross-validation for time series
  - Bayesian statement is $p(\tilde{y}_{\_(t+1)}|y_{\_t}\theta)$
- ROC as measure of performance

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How cryptic is cryptic diversity? Machine learning approaches to classifying morphological variation in the Pacific Pond Turtle (*Emys marmorata*)

- estimate which species classification is best supported by morphology
    - multiple machine learning approaches
    - focus on one turtle species complex
    - results compared against results from two other turtle datasets
    - comparison of in- and out-of-sample model performance
- collaboration with Ken, Jim Parham, and Bryan Stuart
- submitted to then rejected from Systematic Biology
- resubmitted soon

Modeling the rate at which new species are named.

- collaboration with Stewart Edie; he's lead
- I developed the statistical model
    - zero-inflated Poisson model
    - both Bernoulli and Poisson modeled as time series
    - response is the number of species named per publication per year for each biogeographic province
- targets seem to be PNAS or Systematic Biology
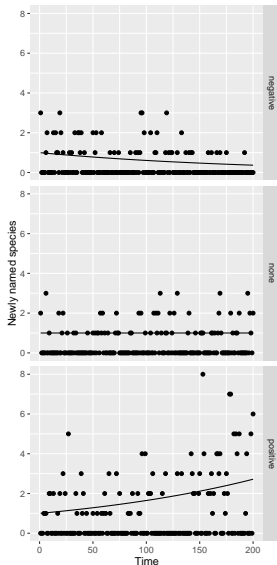
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Post-doc ideas

1. Miller Fellowship at Berkeley with Charles Marshall

   - Charles has met me a couple times.

2. Peter Buck Fellowship at Smithsonian with Gene Hunt
   (and Peter Wagner and Kate Lyons)

   - Gene, Pete, and Kate all know who I am.

3. Michigan Fellowship at University of Michigan
   with Matt Friedman

   - I don't know if he's actually moving there.

4. NIMBiOS Post-doc with Brian O'Meara

   - I don't know him.