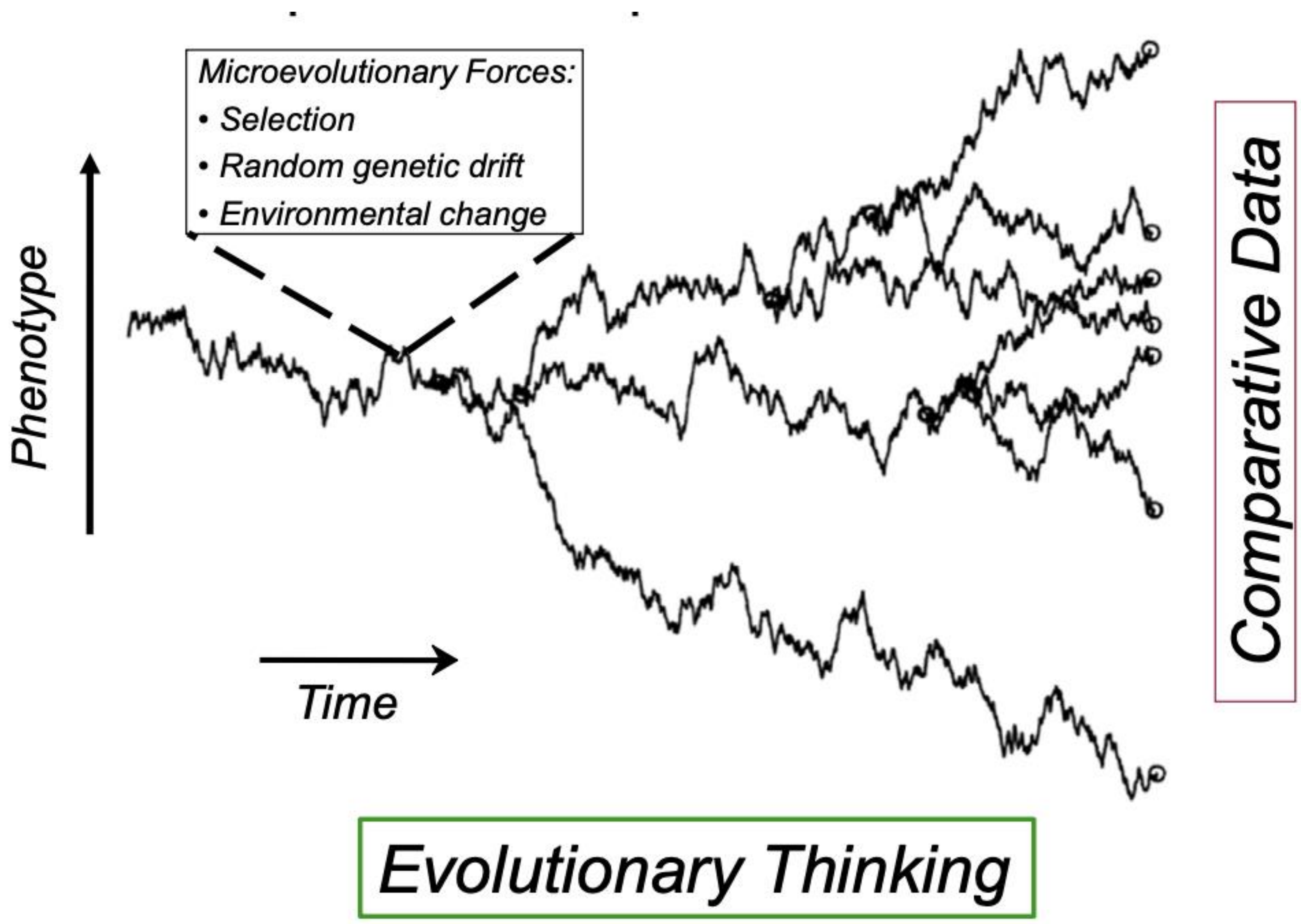
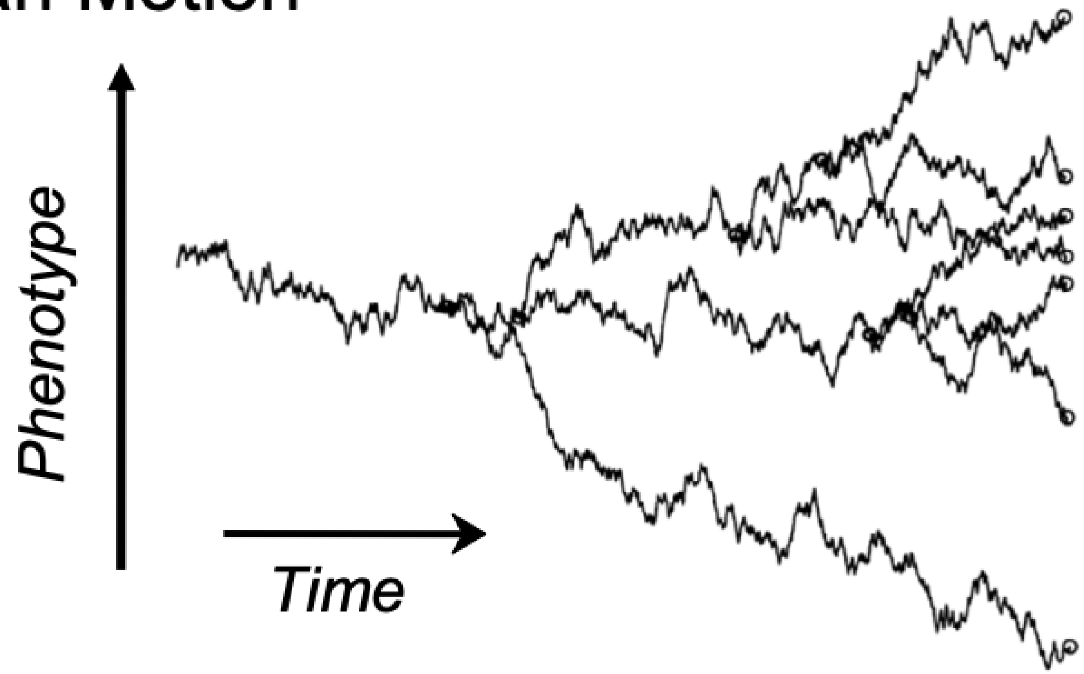
Continuous Trait Correlations

BIO 508- Rosana Zenil-Ferguson


Microevolutionary Forces:
• Selection
• Random genetic drift
• Environmental change
Phenotype
Time
Comparative Data
Evolutionary Thinking

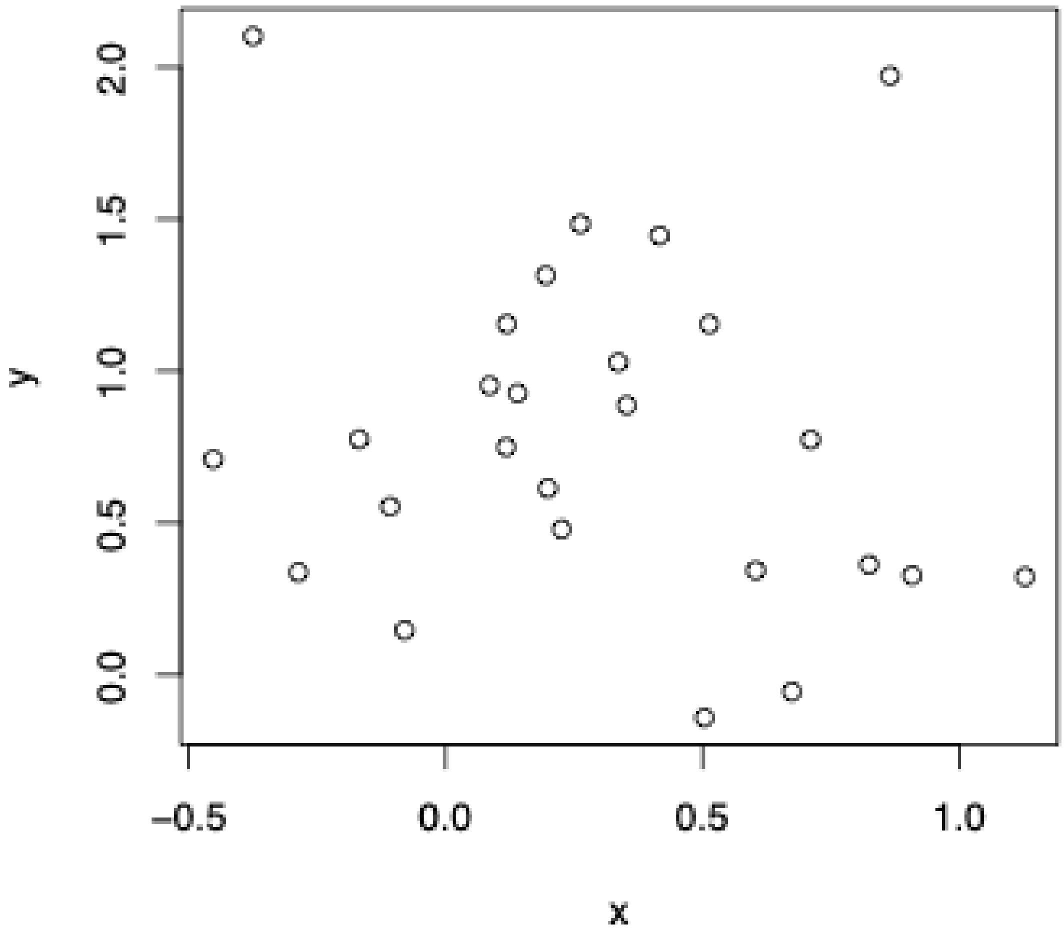
Brownian Motion



Variance = $\sigma^2 t_a$

- Neutral evolution via random genetic drift
- Fluctuating directional selection
- Constant directional selection

Problem: How much of X explains Y



Assumptions of a linear model (linear regression)

1. Linear relationship

2. No Multicollinearity

3. Independence

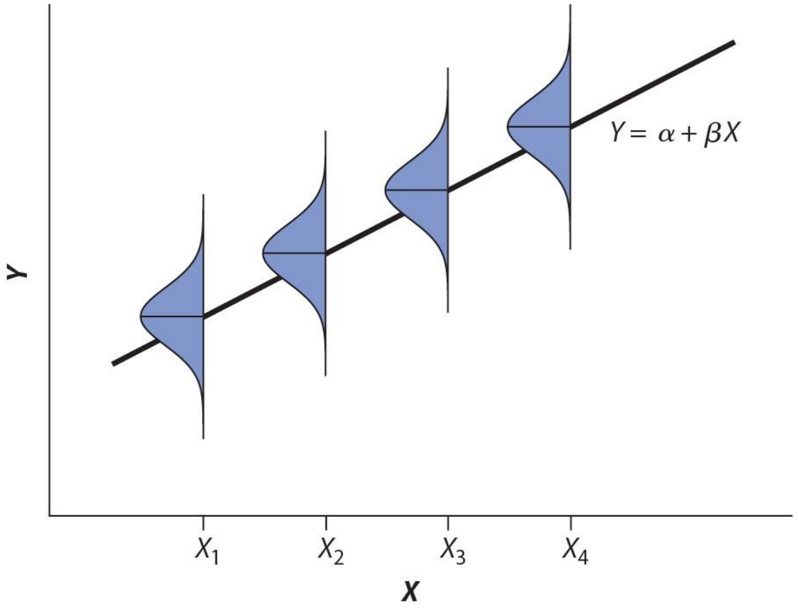
4. Homoscedasticity

5. Residuals distribution

Intercept   Slope   Residual error

$$\text{Pop.size} = \alpha + \beta(\text{Body.size}) + \varepsilon$$

Response variable   Explanatory variable



Residuals are independent and normally distributed

Do bird species with larger average body size have higher abundance?

Sean Nee, Andrew F. Read, Jeremy J. D. Greenwood* & Paul H. Harvey

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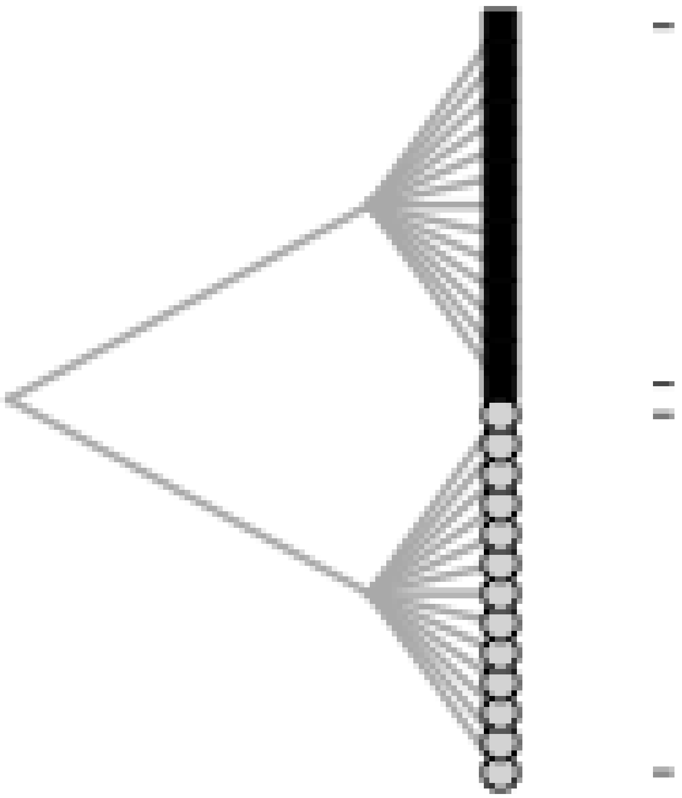
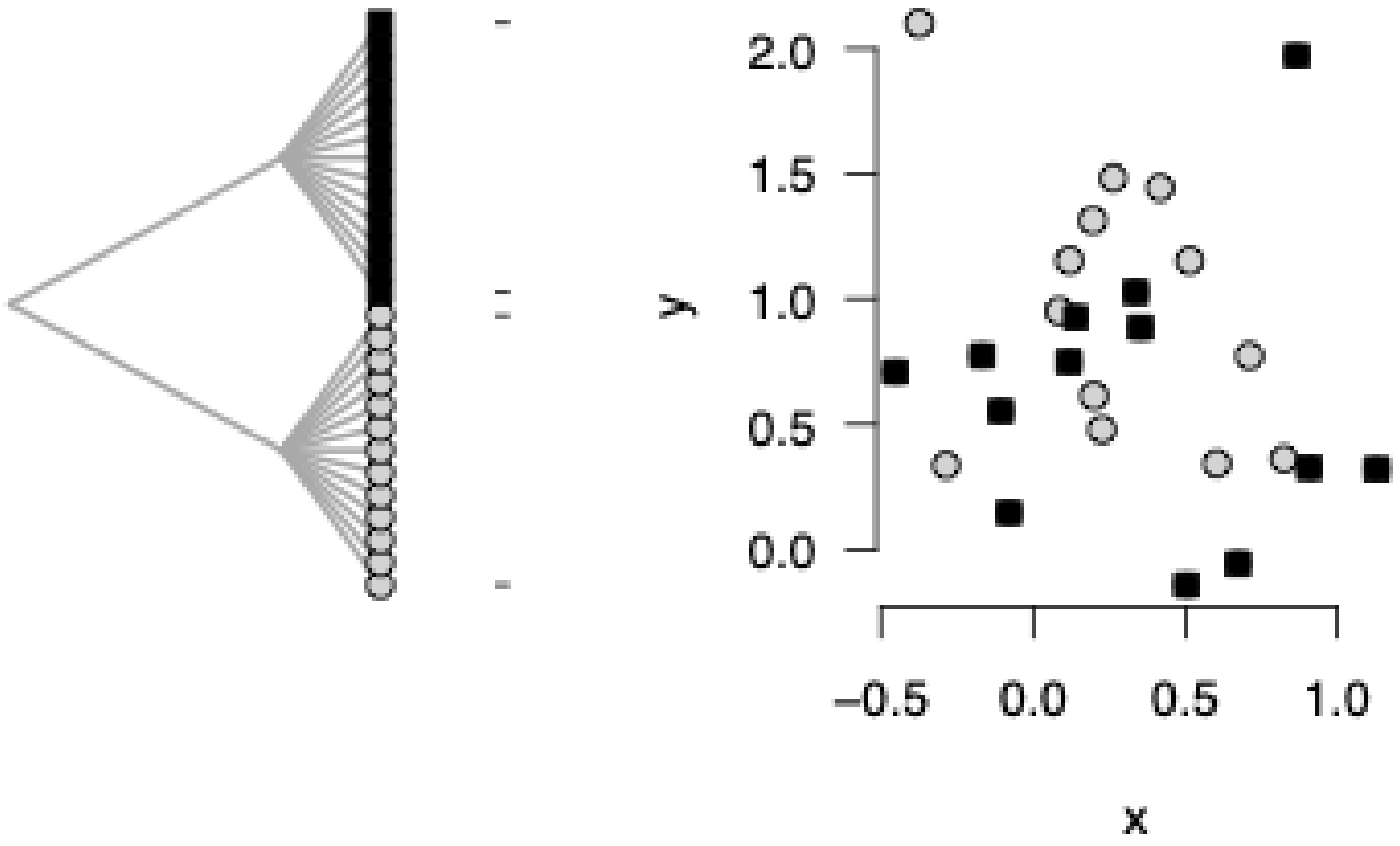
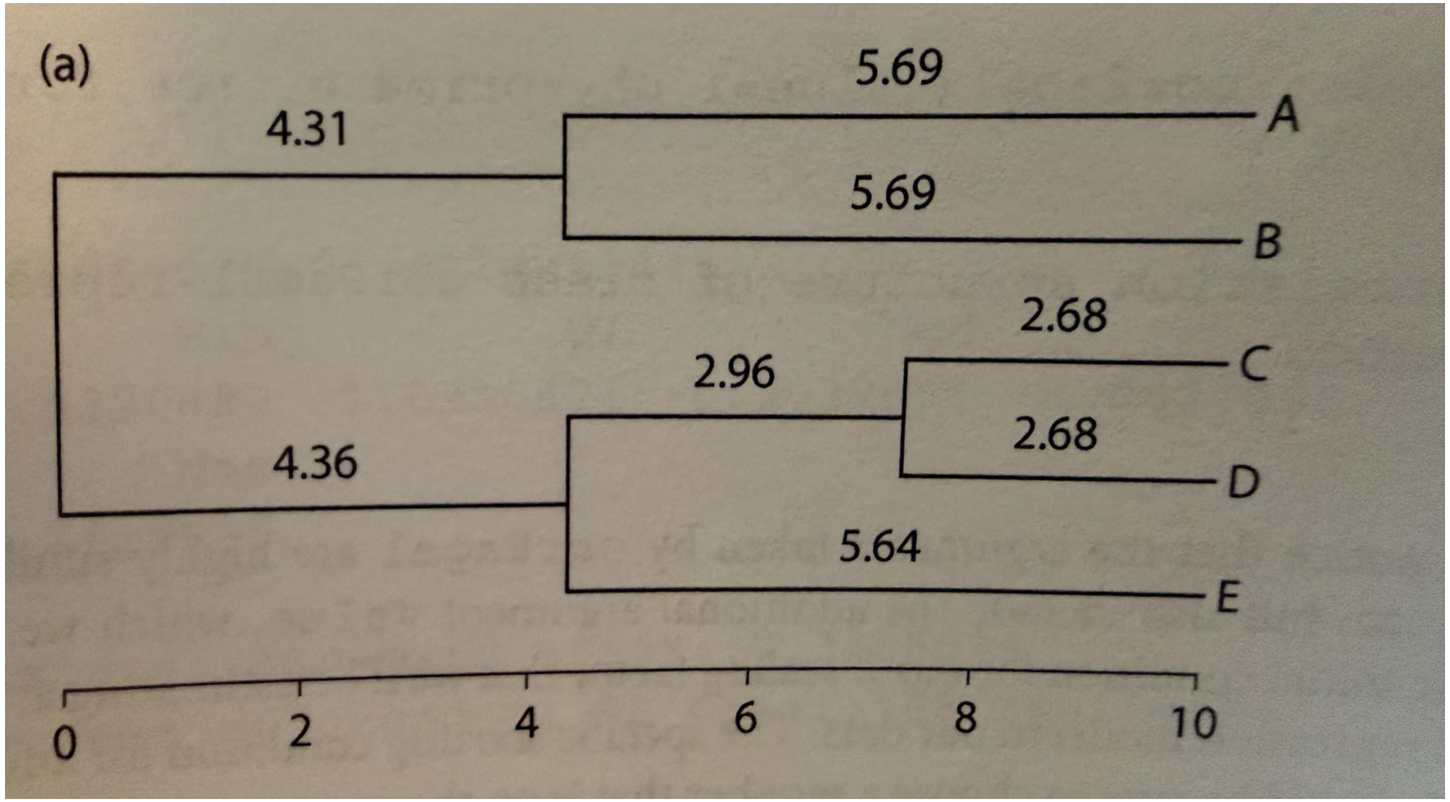
THE relationship between abundance and body size is the subject of considerable debate in ecology[1–15]. Several data sets spanning a large range of body sizes show linear negative relationships between abundance and weight [1–6] when these are measured on a logarithmic scale. But other studies of the abundances of species from single taxa, such as birds, which span a narrower range of body sizes reveal either little or no relationship, or a triangular relationship [9–15]. Errors in estimating abundance might obscure relationships that do exist over a narrow range of body sizes. We

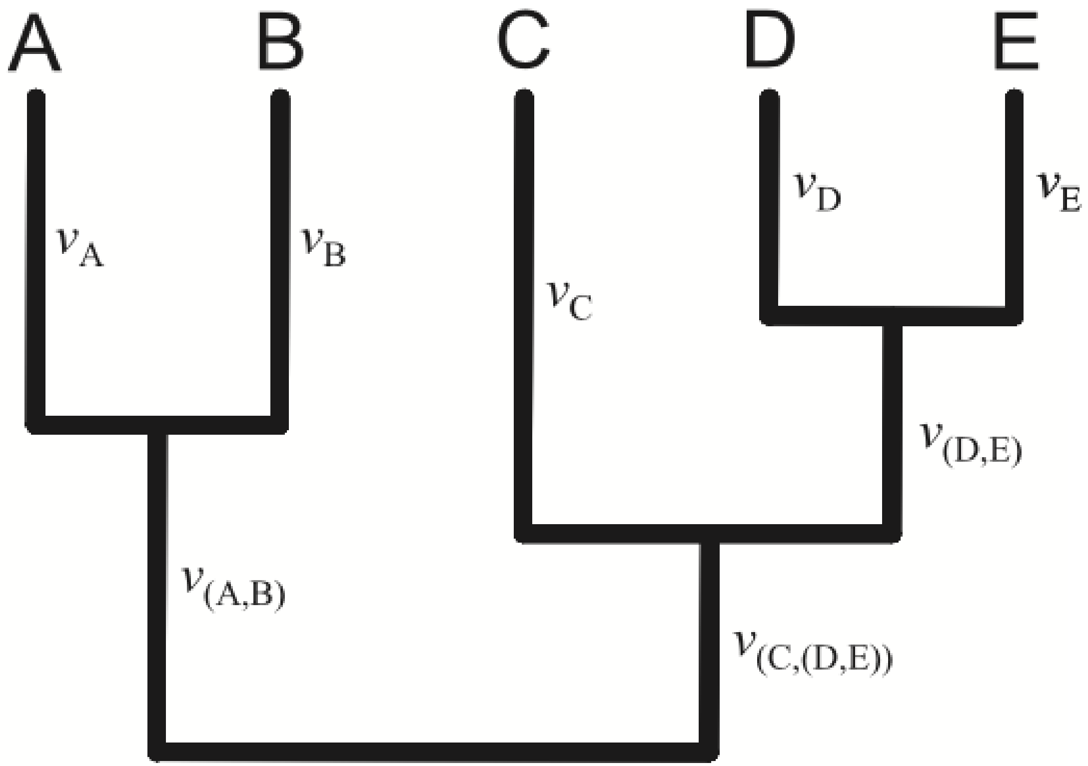
Nee et al. 1991 Nature





2.0
1.5
1.0
0.5
0.0
y
−0.5
0.0
0.5
1.0
x


(a)
5.69
4.31
A
5.69
B
2.68
2.96
C
2.68
4.36
D
5.64
E
0
2
4
6
8
10



(b)

$$\mathbf{C} = \begin{array}{c} \\ A \\ B \\ C \\ D \\ E \end{array} \begin{array}{c} \begin{array}{ccccc} A & B & C & D & E \end{array} \\ \left[\begin{array}{ccccc} v_{(A,B)}+v_A & v_{(A,B)} & 0{\cdot}00 & 0{\cdot}00 & 0{\cdot}00 \\ v_{(A,B)} & v_{(A,B)}+v_B & 0{\cdot}00 & 0{\cdot}00 & 0{\cdot}00 \\ 0{\cdot}00 & 0{\cdot}00 & v_{(C,(D,E))}+v_C & v_{(C,(D,E))} & v_{(C,(D,E))} \\ 0{\cdot}00 & 0{\cdot}00 & v_{(C,(D,E))} & v_{(C,(D,E))}+v_{(D,E)}+v_D & v_{(C,(D,E))}+v_{(D,E)} \\ 0{\cdot}00 & 0{\cdot}00 & v_{(C,(D,E))} & v_{(C,(D,E))}+v_{(D,E)} & v_{(C,(D,E))}+v_{(D,E)}+v_E \end{array}\right] \end{array}$$

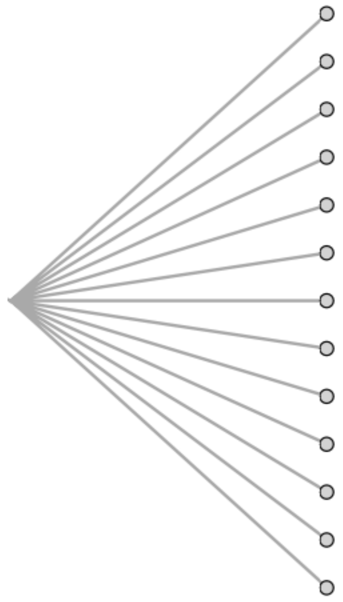
Revell, L. 2010. *Methods in ecology and evolution*

$$Y = \beta X + \varepsilon$$

$$\varepsilon \sim N(0, \sigma^2 I)$$

Strong, rapid selection.
Any force that erases history.

	A	B	C	D	E	F	G	H
A	σ^2	0	0	0	0	0	0	0
B	0	σ^2	0	0	0	0	0	0
C	0	0	σ^2	0	0	0	0	0
D	0	0	0	σ^2	0	0	0	0
E	0	0	0	0	σ^2	0	0	0
F	0	0	0	0	0	σ^2	0	0
G	0	0	0	0	0	0	σ^2	0
H	0	0	0	0	0	0	0	σ^2



Phylogenetic linear model assumptions

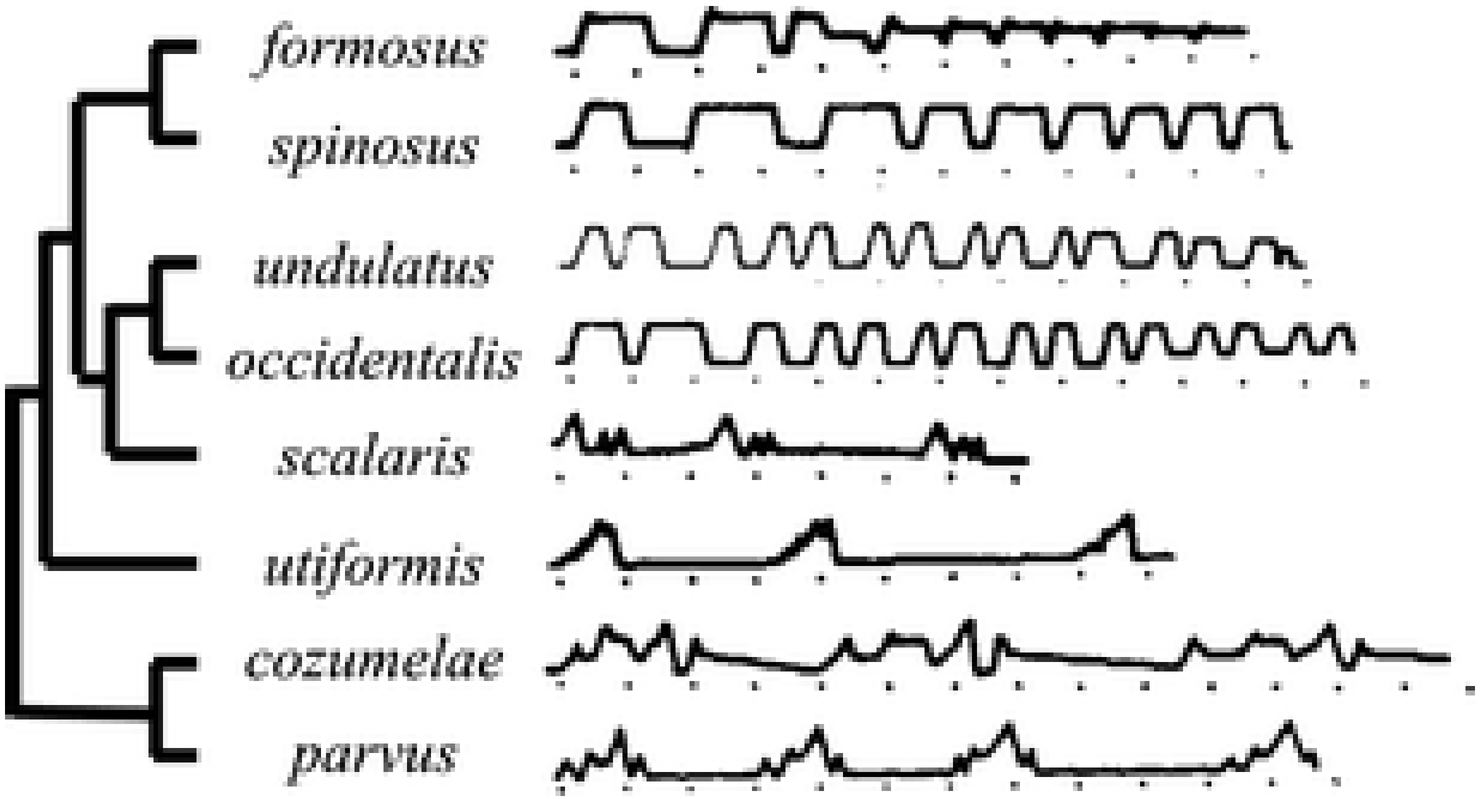
Phylogenetic linear model assumptions

Maximum Likelihood estimates

$$\hat{\boldsymbol{\beta}} = (\mathbf{X}'\mathbf{C}^{-1}\mathbf{X})^{-1}\mathbf{X}'\mathbf{C}^{-1}\mathbf{y}.$$

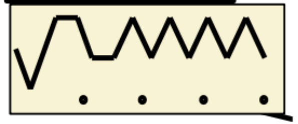
$$\sigma_{\varepsilon}^{2} = (1/n)(\mathbf{y} - \mathbf{X}\hat{\boldsymbol{\beta}})'\mathbf{C}_{\lambda}^{-1}(\mathbf{y} - \mathbf{X}\hat{\boldsymbol{\beta}}).$$

Lizard head bobbing

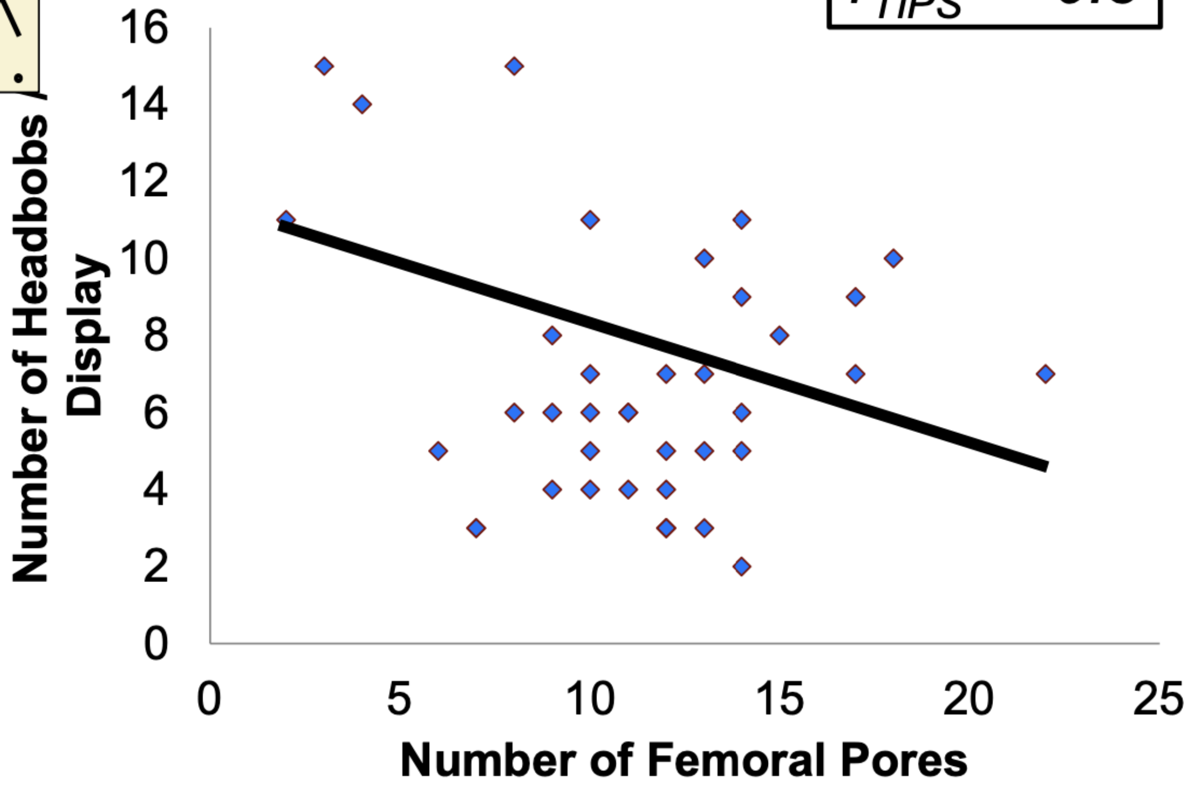


Motion & chemical signals

Motion



r_{TIPS} = -0.3

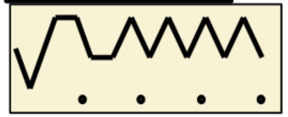


Chemicals

Ossip-Klein et al. 2013; BEAS

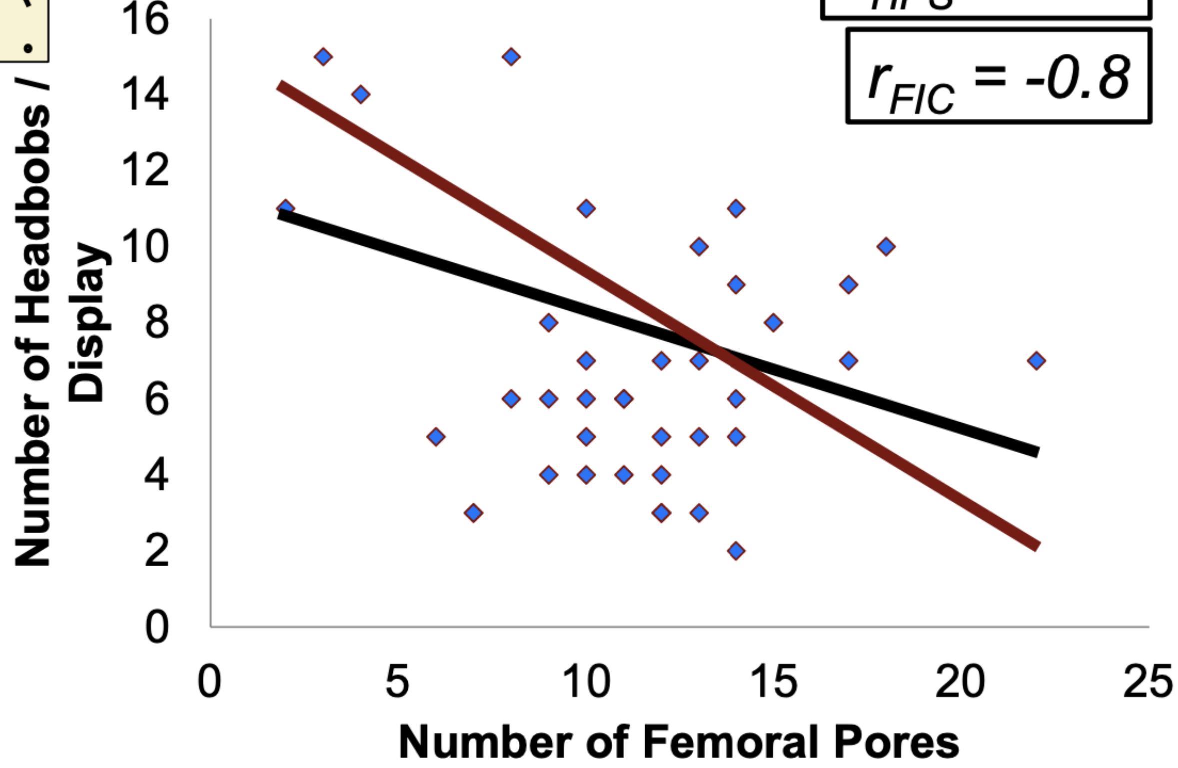
Motion & chemical signals

Motion



r_{TIPS} = -0.3

r_{FIC} = -0.8



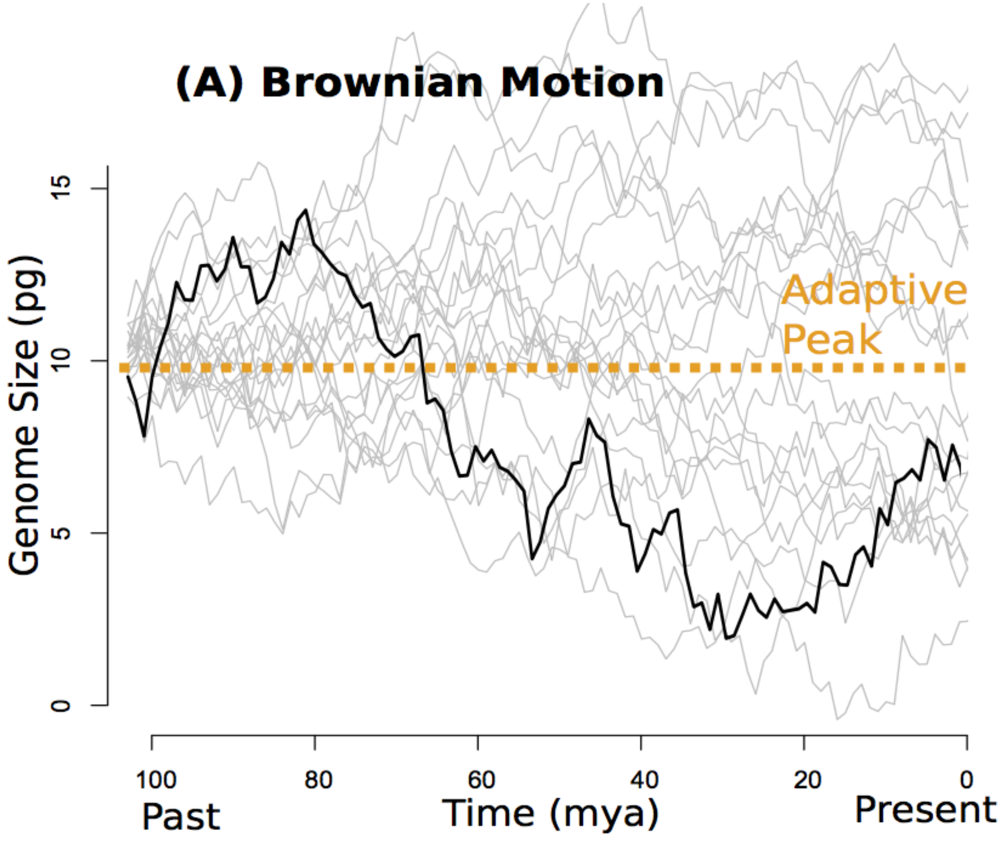
Chemicals

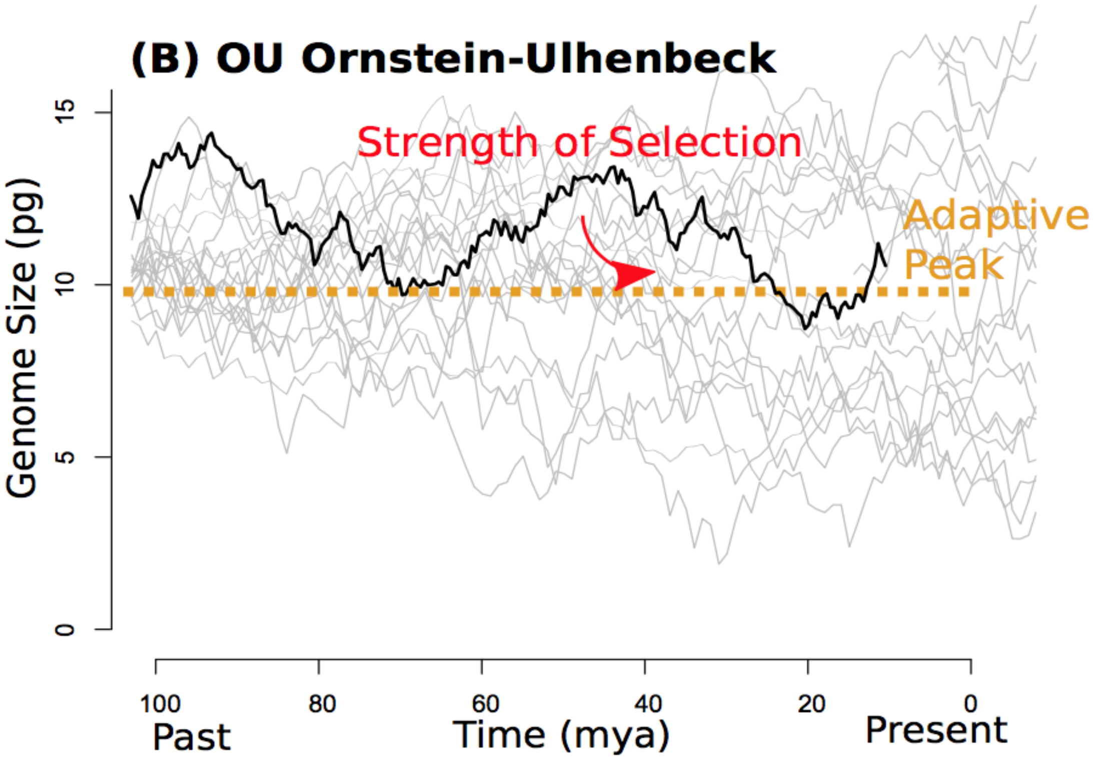
Trade-off between motion and chemicals
Phylogeny clarifies relationship between traits.

Ossip-Klein et al. 2013; BEAS

BM may not be a good model of :

1. Most forms of selection
2. Phenotypic plasticity





BM: $\mathrm{var}(\varepsilon)_{ij} = \sigma^2 t_a$

OU: $\mathrm{var}(\varepsilon)_{ij} = \gamma \exp[-\alpha t_{ij}]$