

Trends



http://pinchmealfredo.blogspot.com/2008_11_01_archive.html



http://scienceblogs.com/deepseanews/2007/04/why_is_the_giant_isopod_giant.php

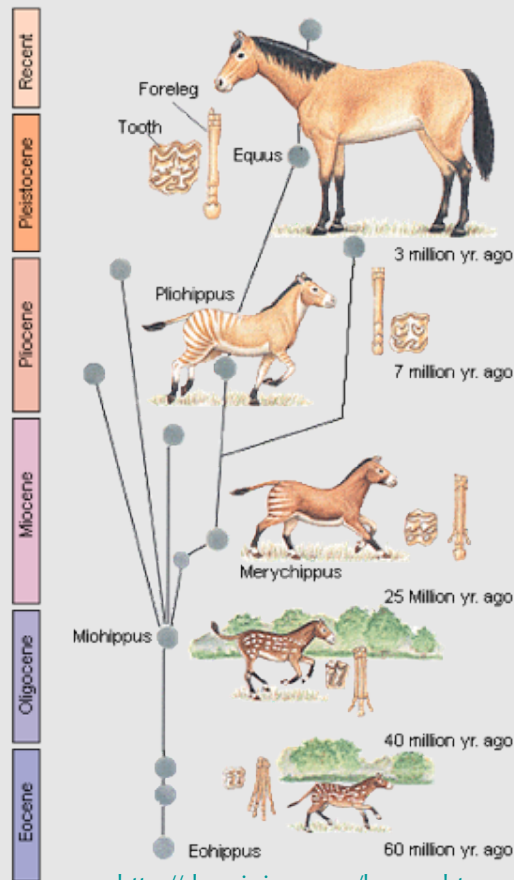
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EEB464 Fall 2019

Learning objectives

- Understand kinds of biological trends
- Describe ways to test these trends

Cope's Rule

Widespread tendency of many animal groups to grow towards larger sizes



<http://darwiniana.org/horses.htm>

What could
explain a trend?

How would
you test it?

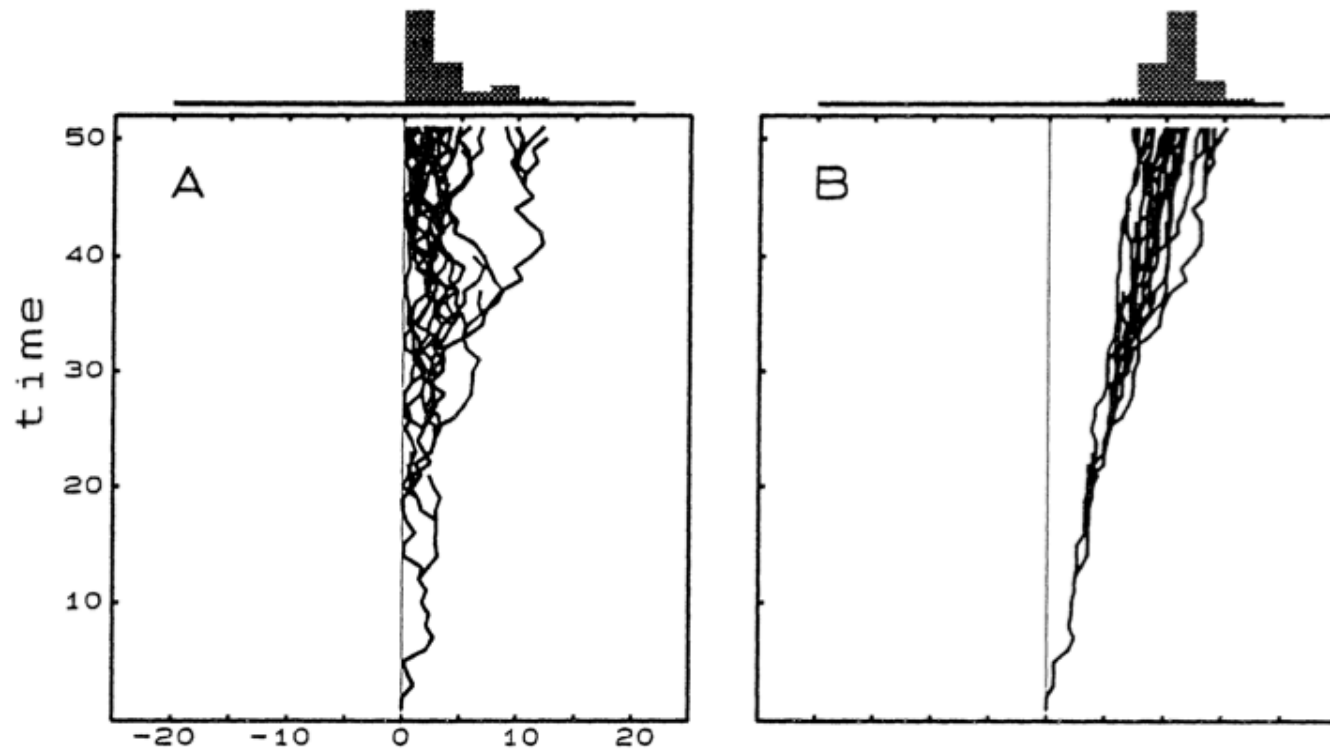


Fig. 1. Simulation of the diversification of a clade in a passive (A) and a driven (B) system. The horizontal dimension is unspecified, but it could be almost any variable (e.g., size, metabolic rate, speciation rate, location in space). See text for discussion of the general features of the computer model. In the passive system, a cushioning boundary is present at zero, meaning lineages that would otherwise cross the boundary are assigned their original value. In the driven system, no boundary is present, but increases are more likely than decreases. Histograms above show distributions for the clades after 50 time units.

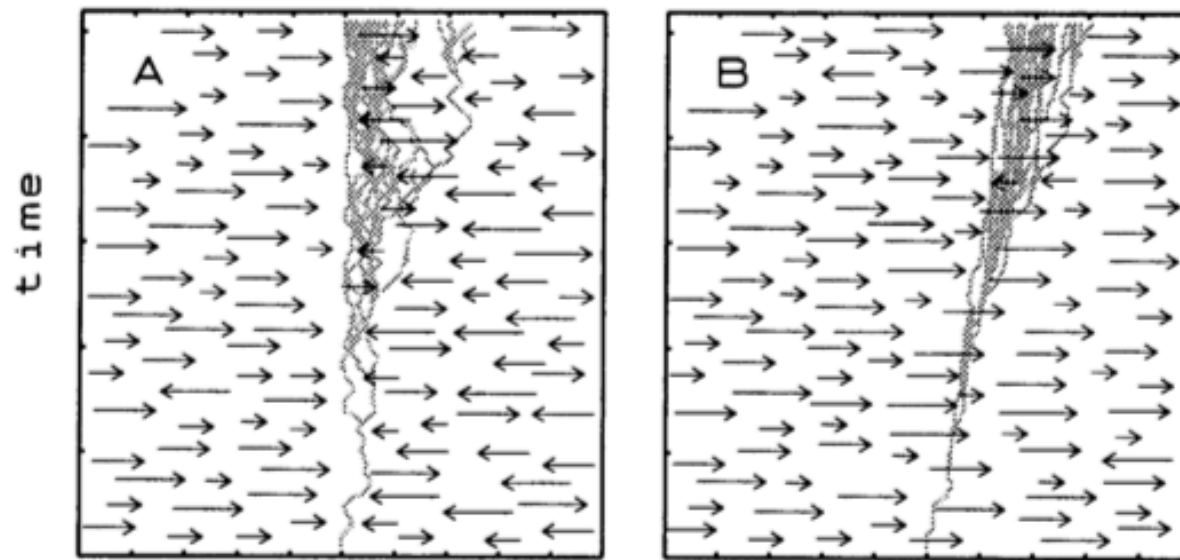
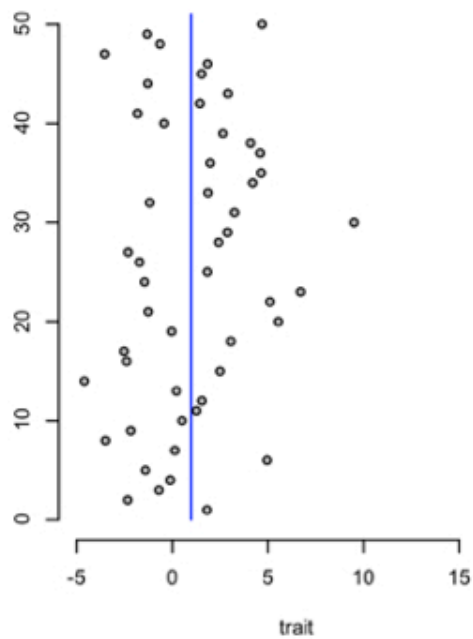
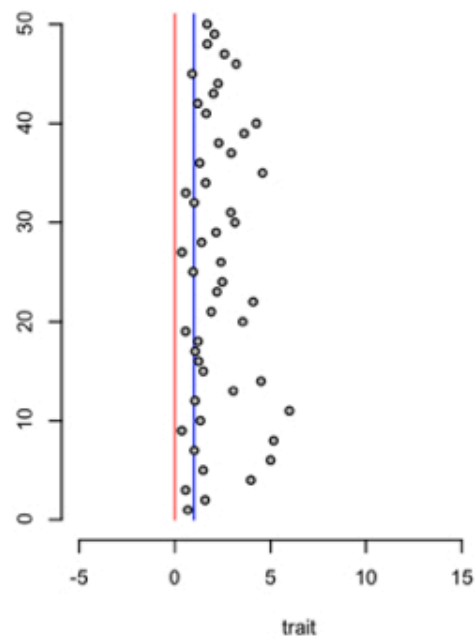
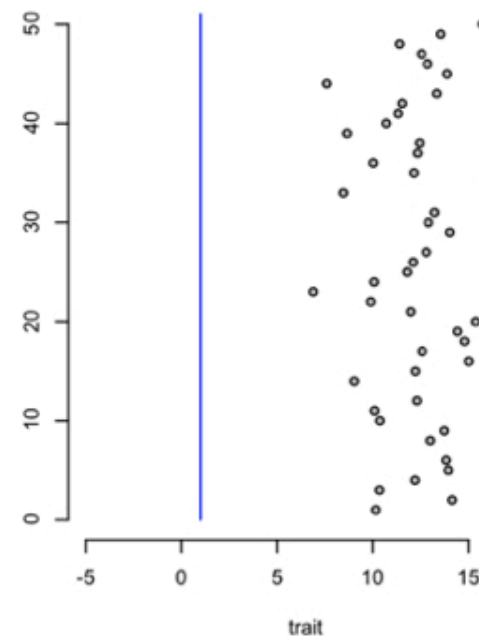
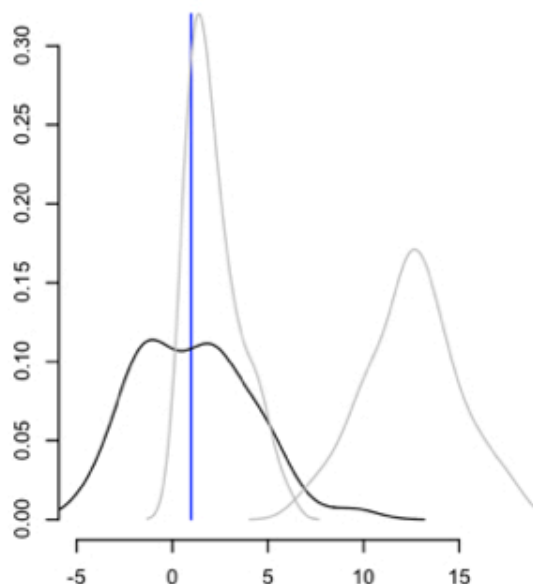
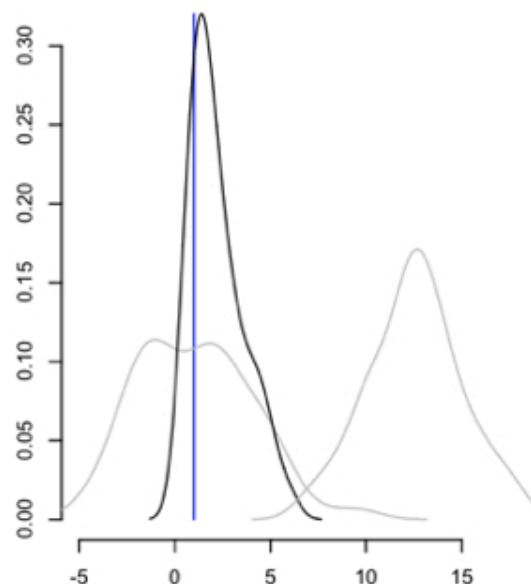
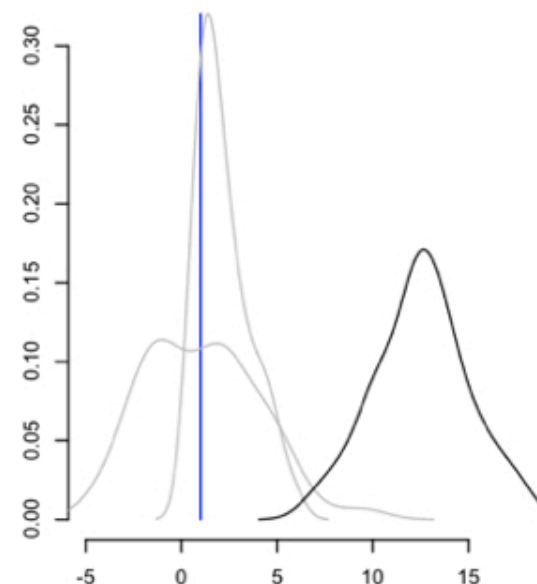
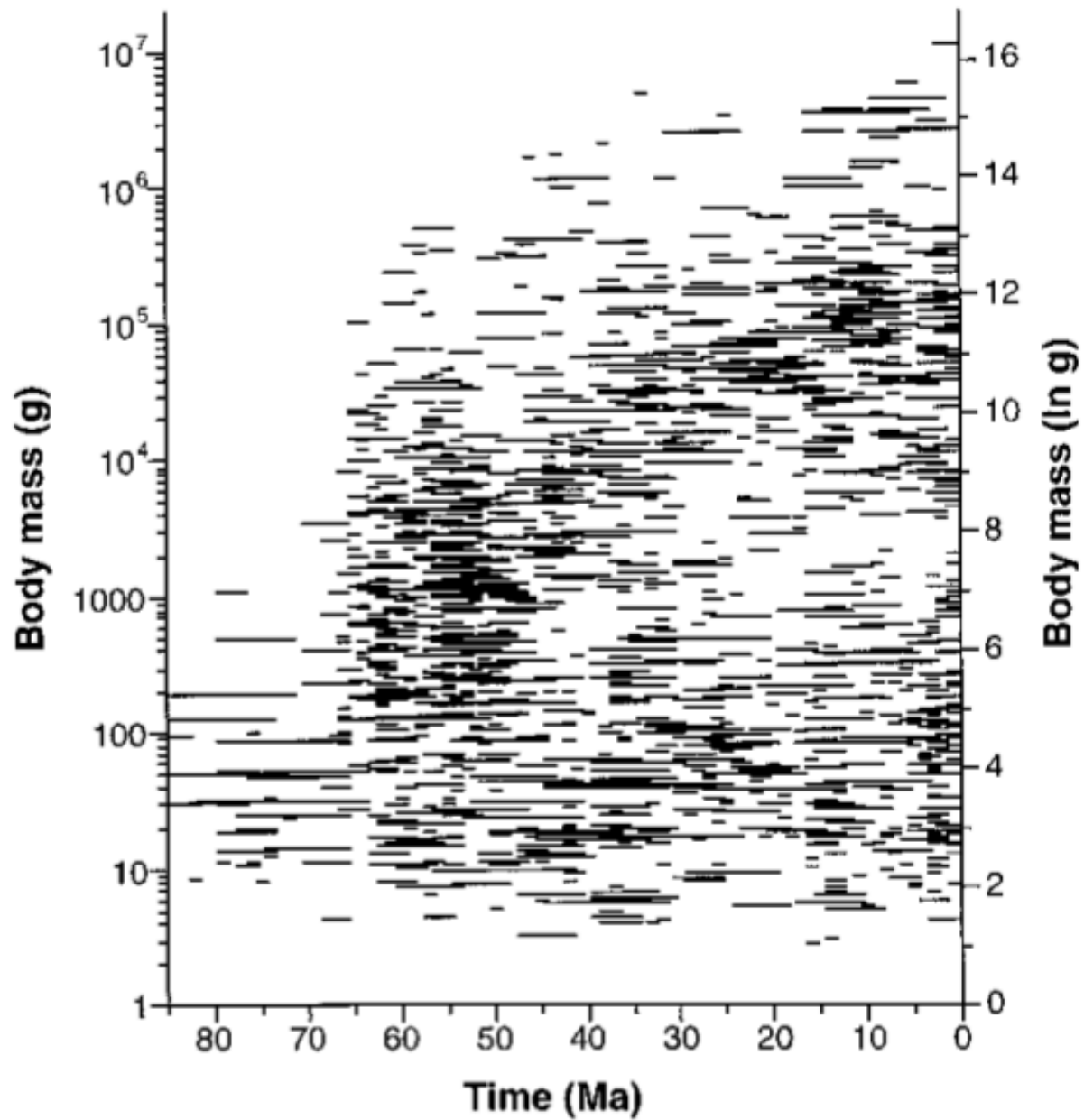
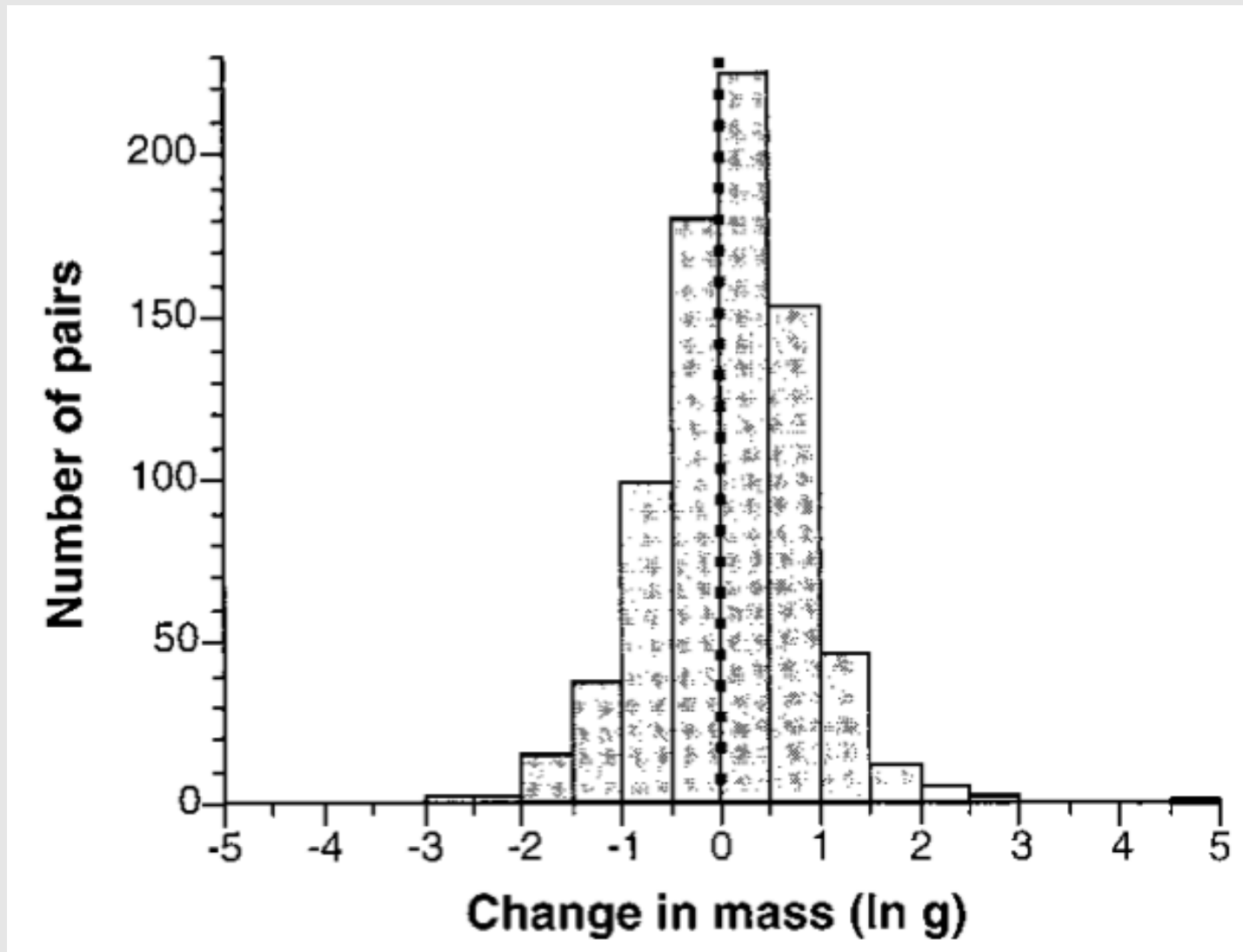


FIG. 4. Modification of figure 1 to show the sense in which a passive trend (A) occurs in a heterogeneous space and a driven trend (B) in a homogeneous space, with vectors representing regimes of evolutionary forces acting in concert (force fields). In the driven system, the field is more or less homogeneous in space and time, driving the lineages to the right. In the passive system, the concerted forces are concentrated on the left, creating a barrier; on the right, the orientation of vectors is random so that no *net* force acts, and diffusion occurs. See text for further discussion.

drift**passive trend****driven trend****drift****passive trend****driven trend**





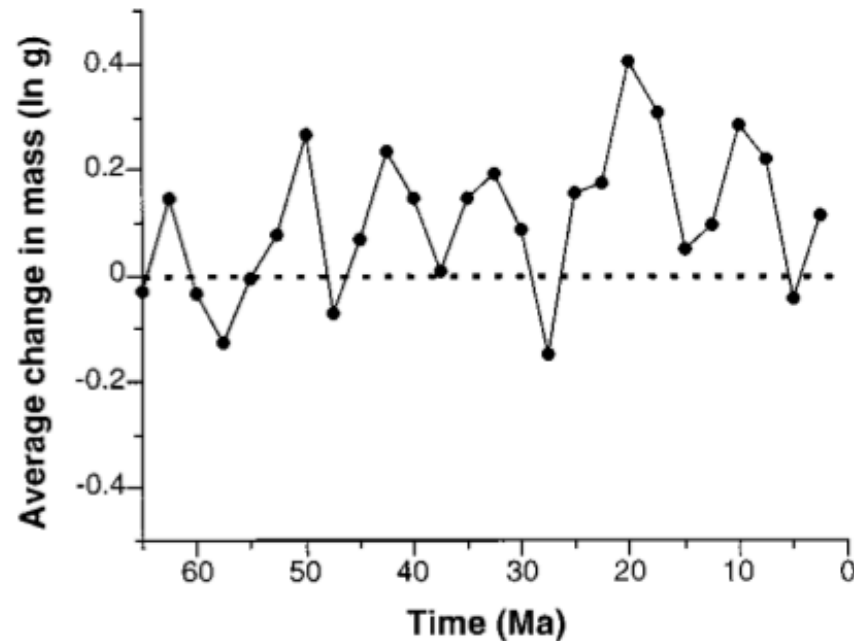
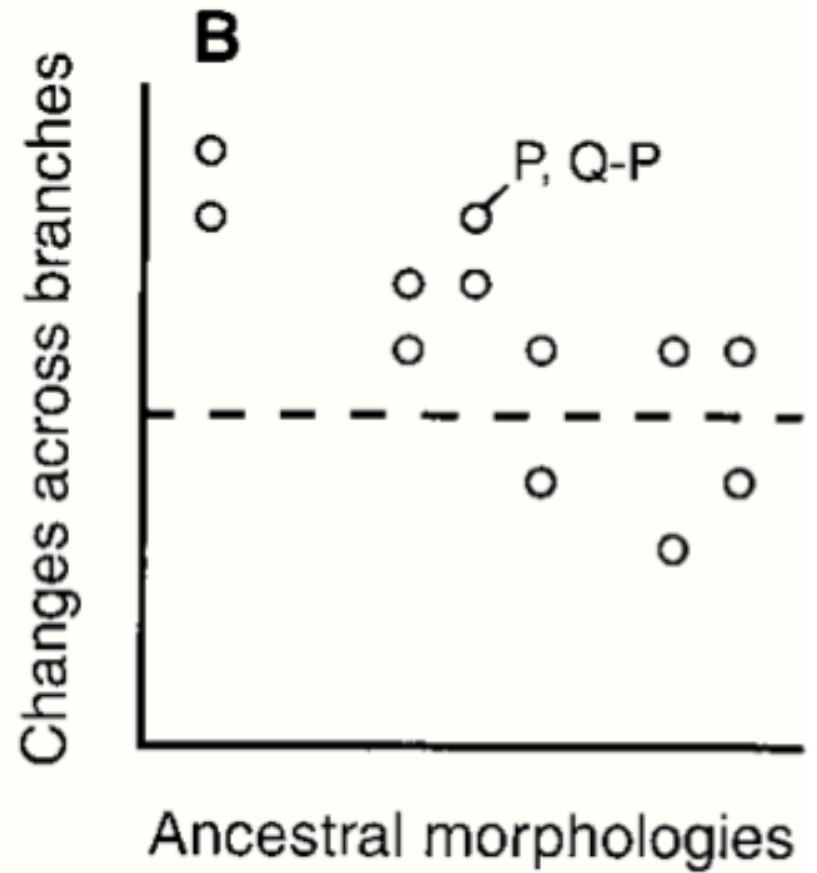
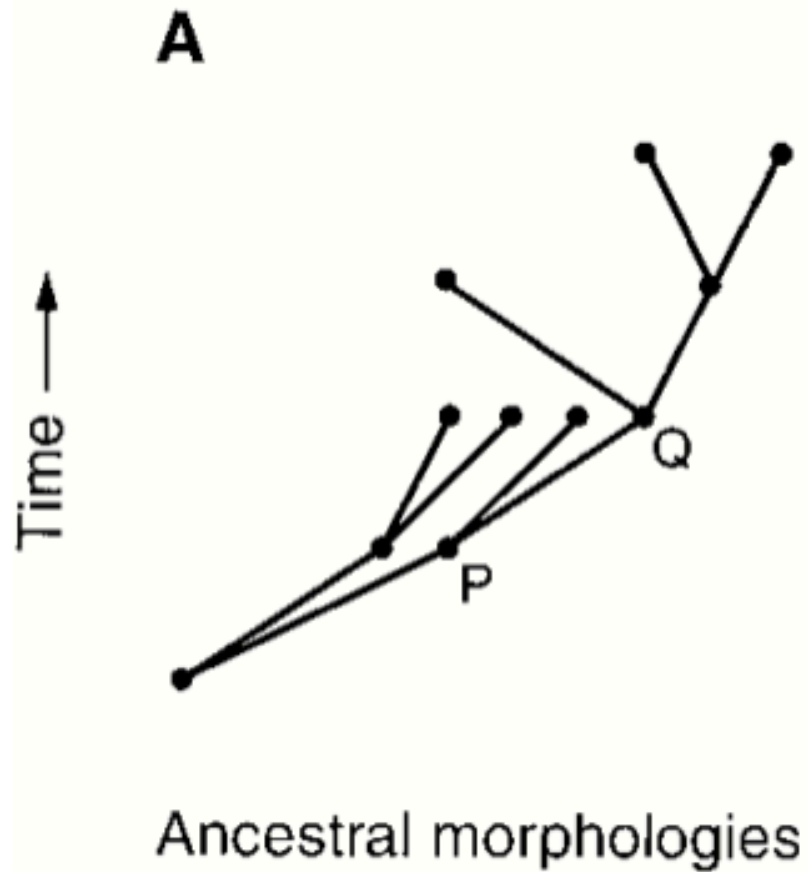


Fig. 3. Trend in strength of the within-lineage Cope's rule effect through the Cenozoic. Here, the data shown in Fig. 2 are binned into intervals 2.5 My long and averaged. Sample sizes range from 12 to 79 older-younger species pairs per interval, with an average of 29.1. Alternative bin sizes of 1 to 10 My yield similar patterns. Cretaceous data are too sparse to allow reliable averages to be computed. The dashed line illustrates the expected average change of zero if there is no effect.



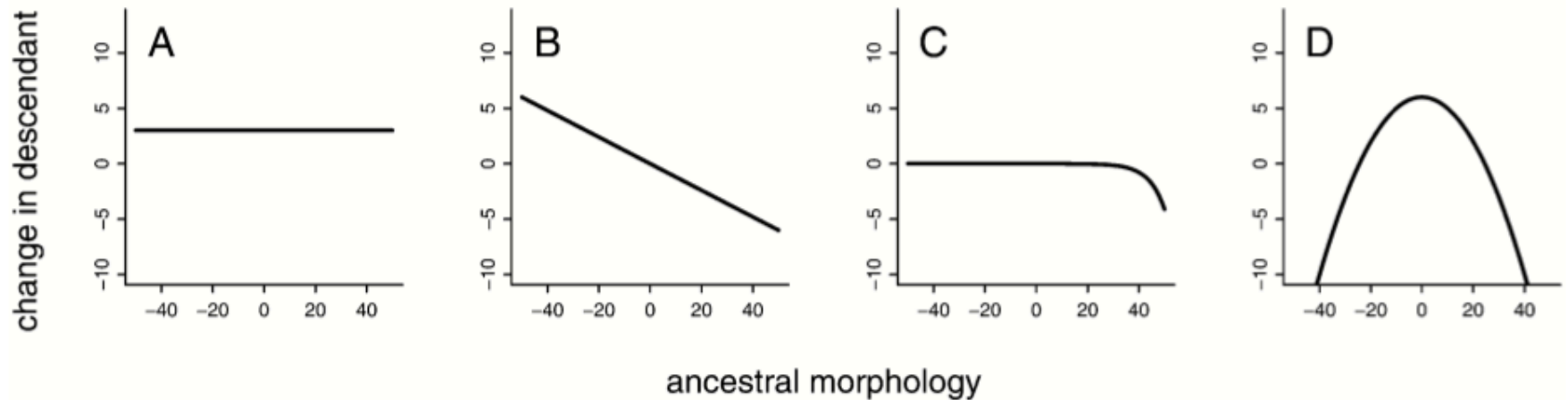


FIGURE 2. Examples of change-vs.-ancestor plots. A, A system exhibiting a simple driven trend. Average ancestor-descendant change is positive and constant for all ancestral morphologies. B, A system exhibiting a stable equilibrium (a “point attractor”) at size = 0 units. Taxa below this point tend to increase on average, and taxa above this point tend to decrease. C, A system exhibiting an upper bound. All taxa have zero average change except taxa with the largest morphologies, which tend to decrease on average. D, A system exhibiting two equilibria at size = ± 30 . An unstable equilibrium (a “repeller”) occurs at size = -30 ; taxa below this point tend to decrease on average, and taxa slightly above this point tend to increase. A stable equilibrium (a “point attractor”) occurs at size = $+30$; taxa slightly below this point tend to increase on average, and taxa above this point tend to decrease.

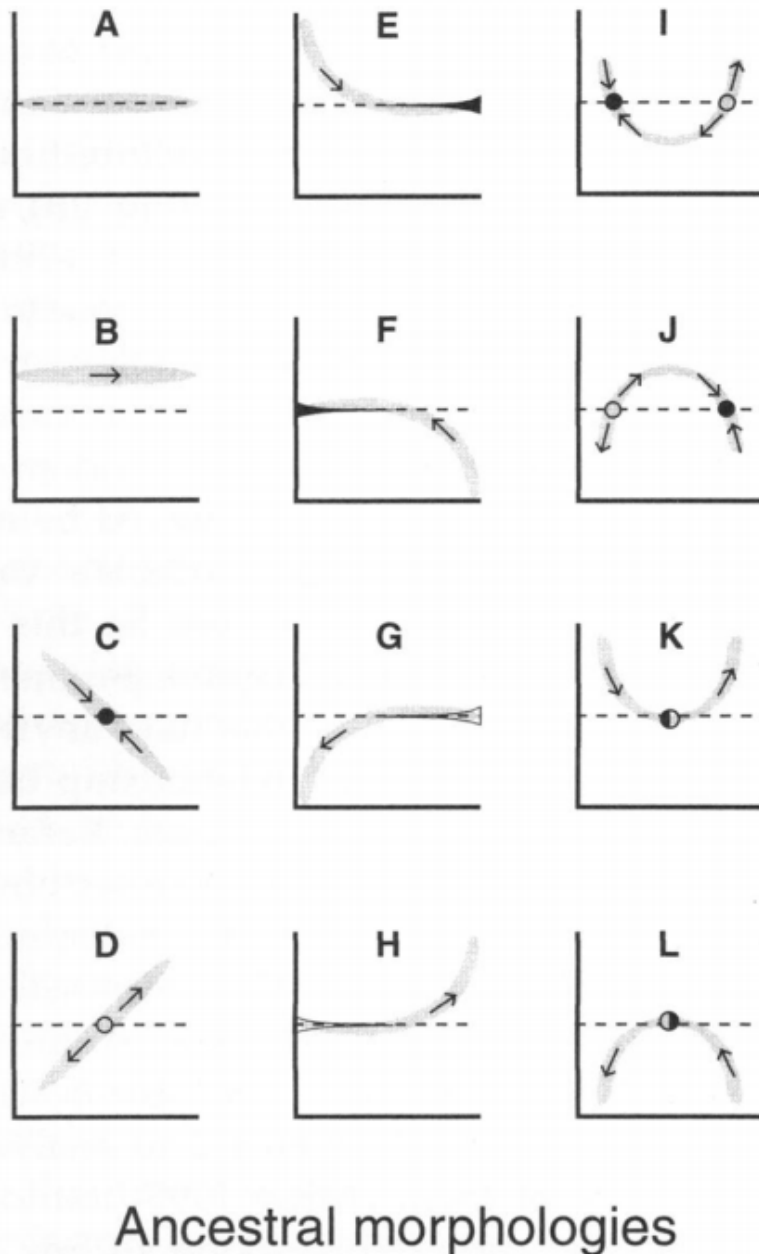
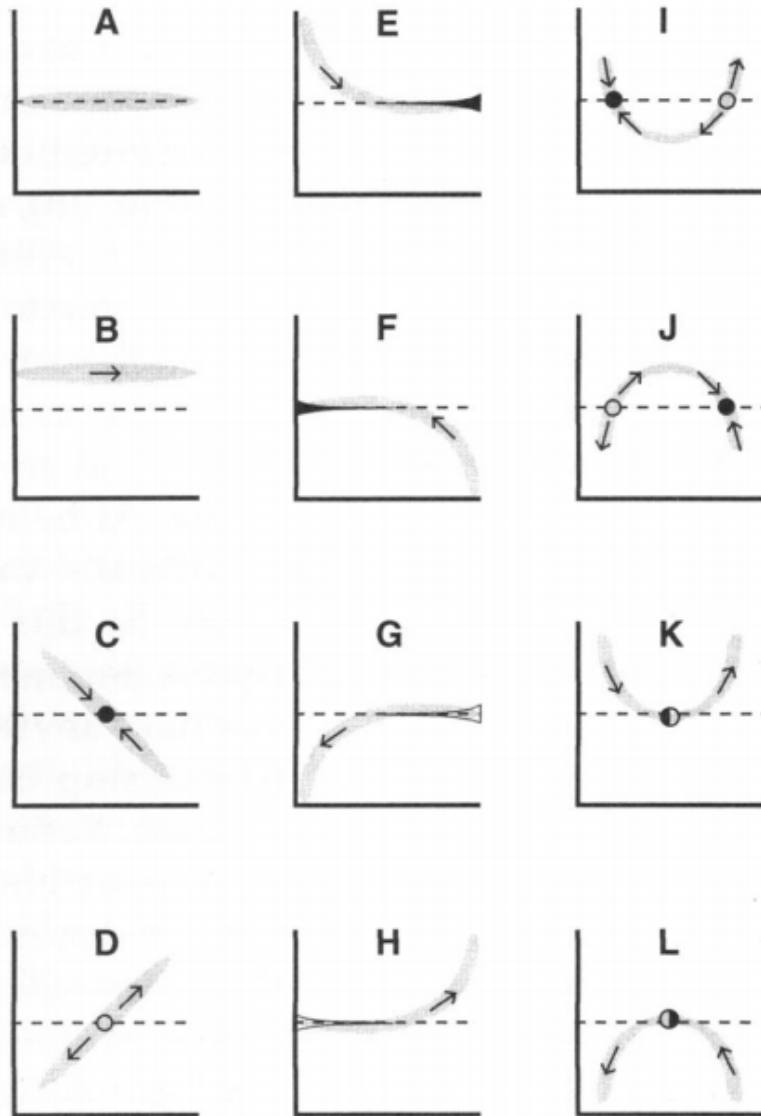


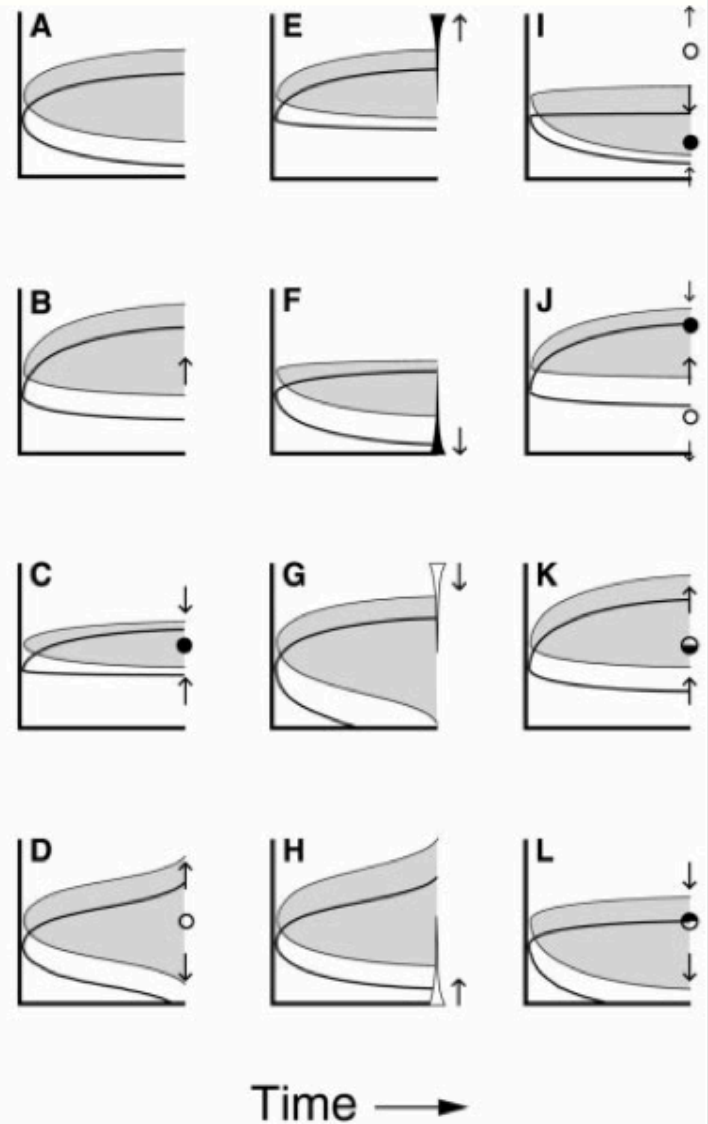
FIGURE 2. Sketches of qualitatively distinct dynamics of evolutionary change. Ancestral morphological values (e.g., size or complexity) are contrasted with differences between descendants and ancestors (e.g., amounts of evolutionary change in size or complexity). Dashed lines indicate evolutionary changes of zero; filled circles and tapering shapes are stable equilibria; open circles and tapering shapes are unstable equilibria; arrows show expected directions of change toward stable equilibria or away from unstable equilibria; gray shapes suggest possible scatters of data points. A, Random change. B, Constant, directed bias. C, Single stable point equilibrium. D, Single unstable point equilibrium. E, Stable equilibrium zone implying a "lower bound." F, Stable equilibrium zone implying an "upper bound." G, Unstable equilibrium zone implying a "lower cliff." H, Unstable equilibrium zone implying an "upper cliff." I, Double point equilibria: lower is stable, upper is unstable. J, Double point equilibria: lower is unstable, upper is stable. K, Point equilibrium that is stable for low values but unstable for high values (i.e., a saddle). L, Point equilibrium (saddle) that is unstable for low values but stable for high values.

Changes across branches



Ancestral morphologies

Morphologies



Time →

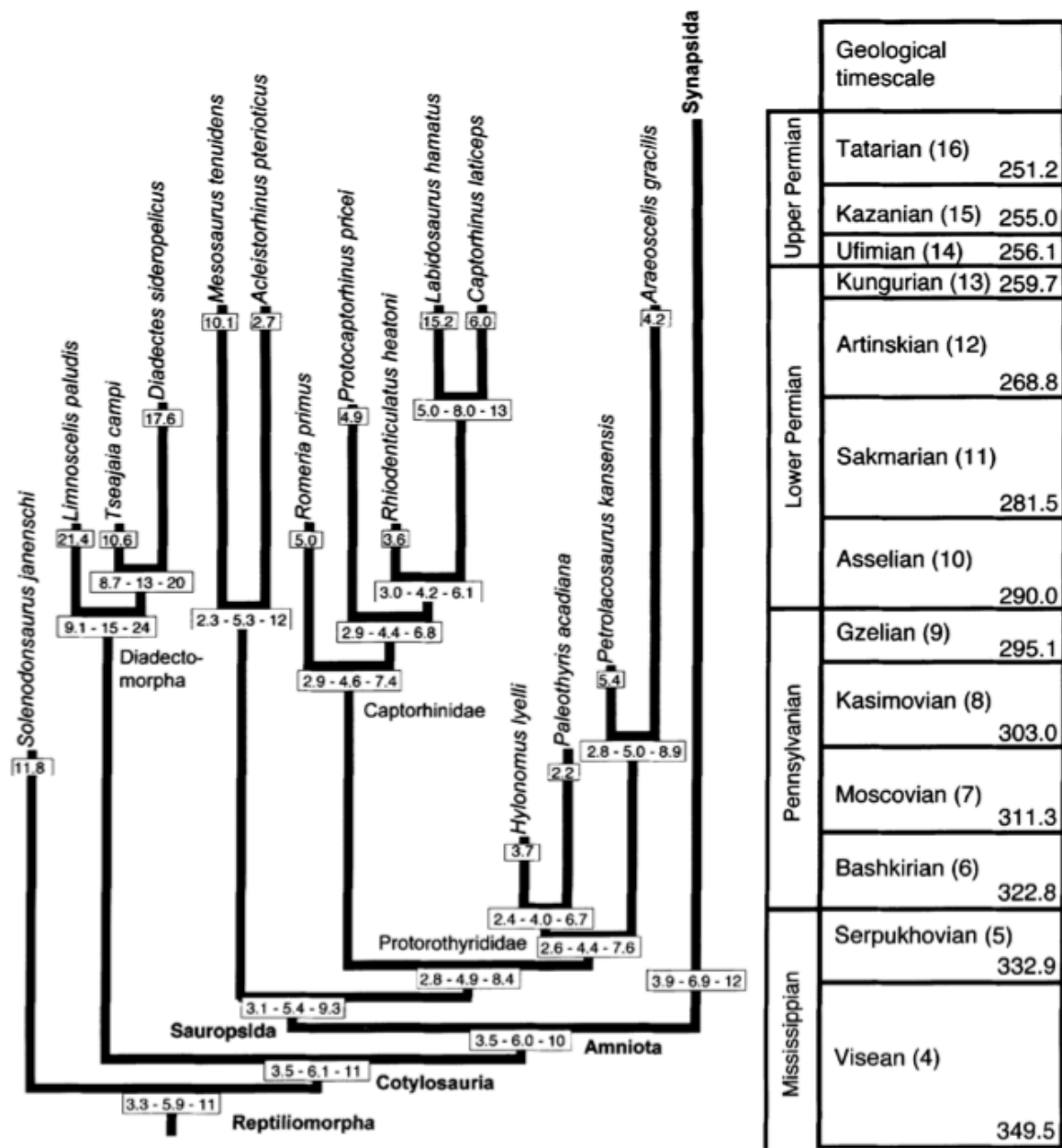


FIGURE 7. Cranial length evolution in reptiliomorphs. All lengths are expressed in cm, and represent the distance from the anterior tip of the premaxilla to the posterior end of the skull table. Abbreviations as in Figure 4. Extant taxa are in bold type.

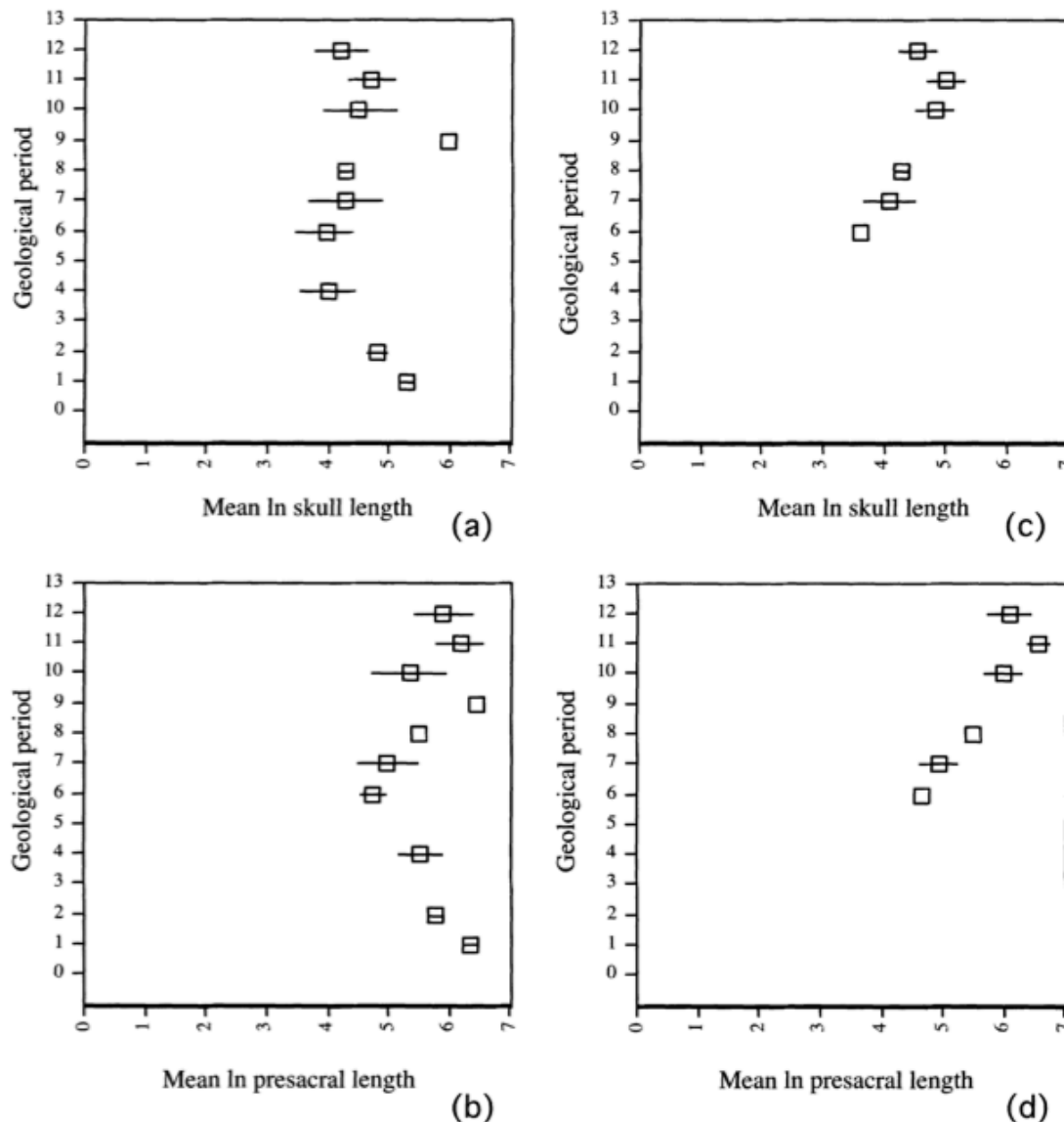
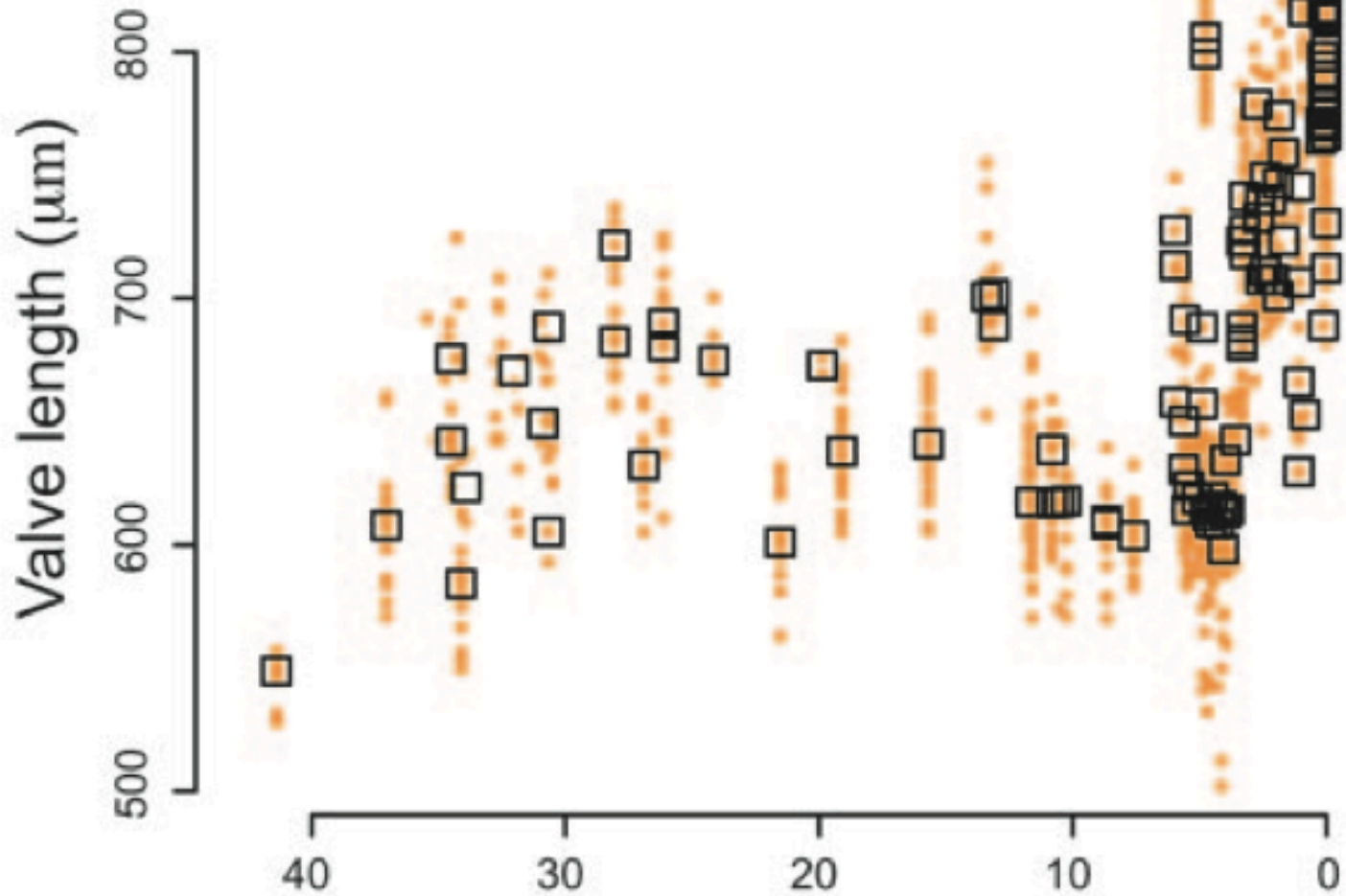
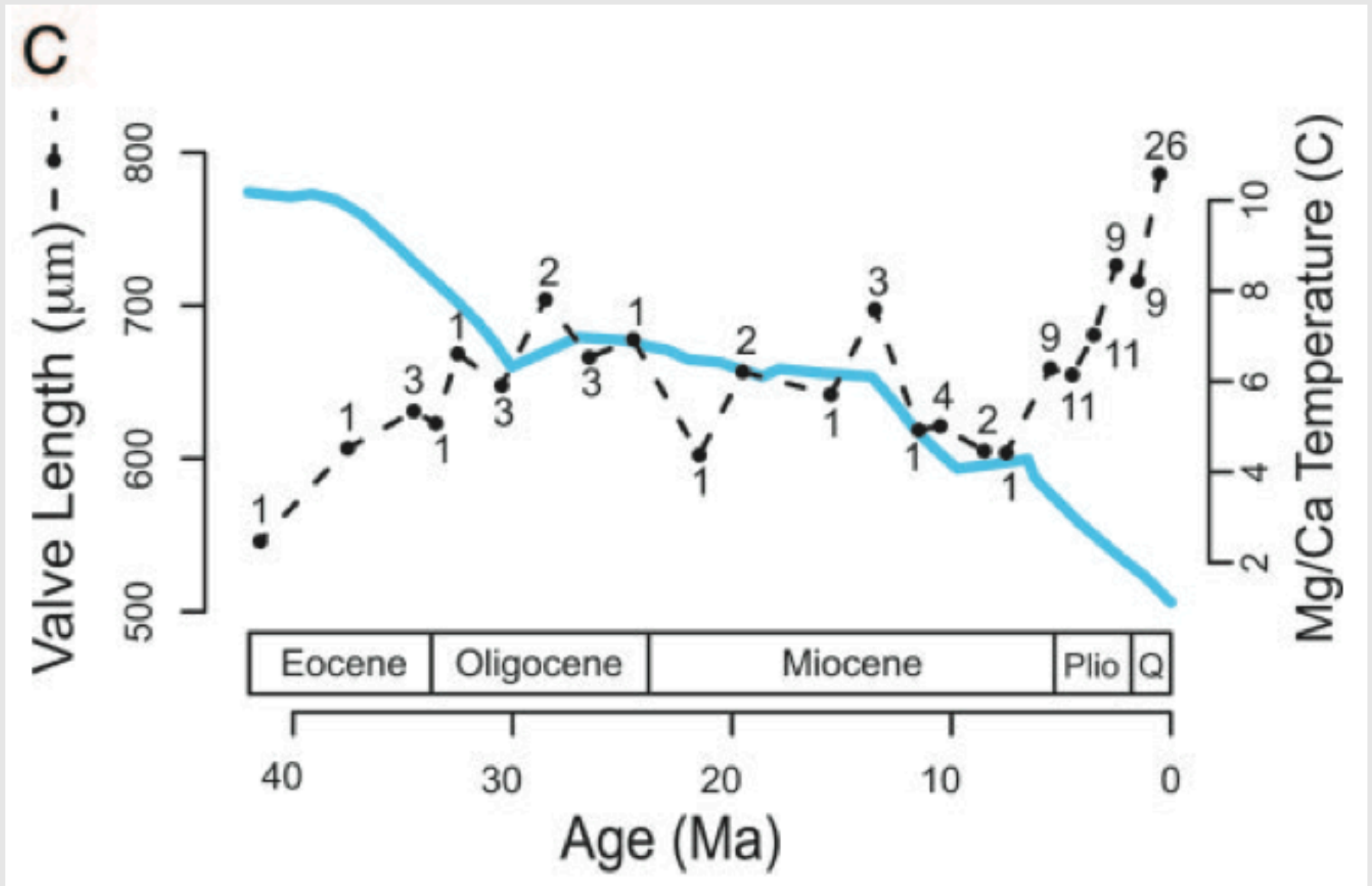


FIGURE 11. Mean body size (x-axis) through time (y-axis). (a) Mean cranial length of stegocephalians. (b) Mean presacral length of stegocephalians. (c) Mean cranial length of reptiliomorphs. (d) Mean presacral length of reptiliomorphs. For reptiliomorphs (c, d), there are no size data before period 6 because reptiliomorphs appear in the fossil record at that time; no size data are available for that group in period 9. In period 1, sampled taxa are finned, primitively aquatic sarcopterygians closely related to stegocephalians; periods 2 to 12 are represented only by stegocephalians. The time periods are defined in Appendix 3. All values have been log-transformed (ln of the dimensions, in mm). The horizontal bars passing through each point represent the standard deviation. Points without bars represent single values. There are no data for period 3.

A

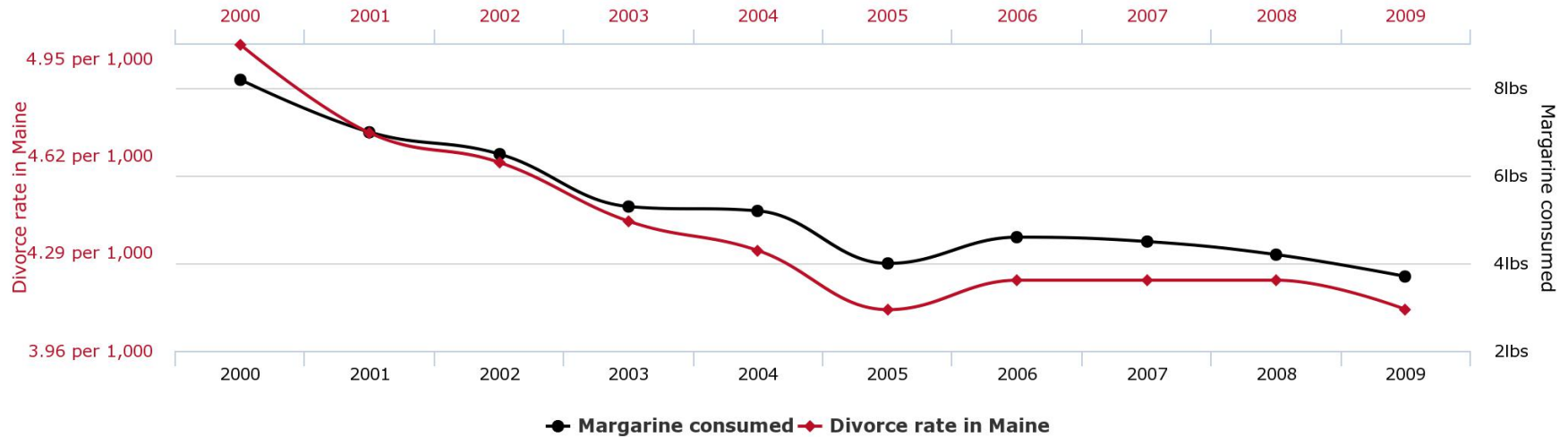
Time



Divorce rate in Maine

correlates with

Per capita consumption of margarine

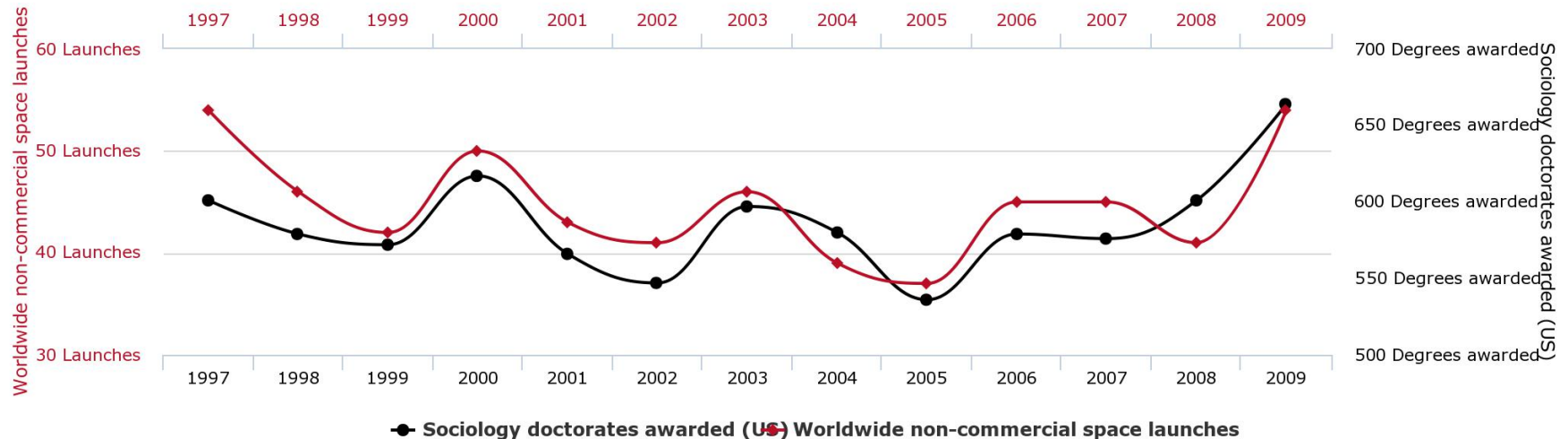


tylervigen.com

Worldwide non-commercial space launches

correlates with

Sociology doctorates awarded (US)



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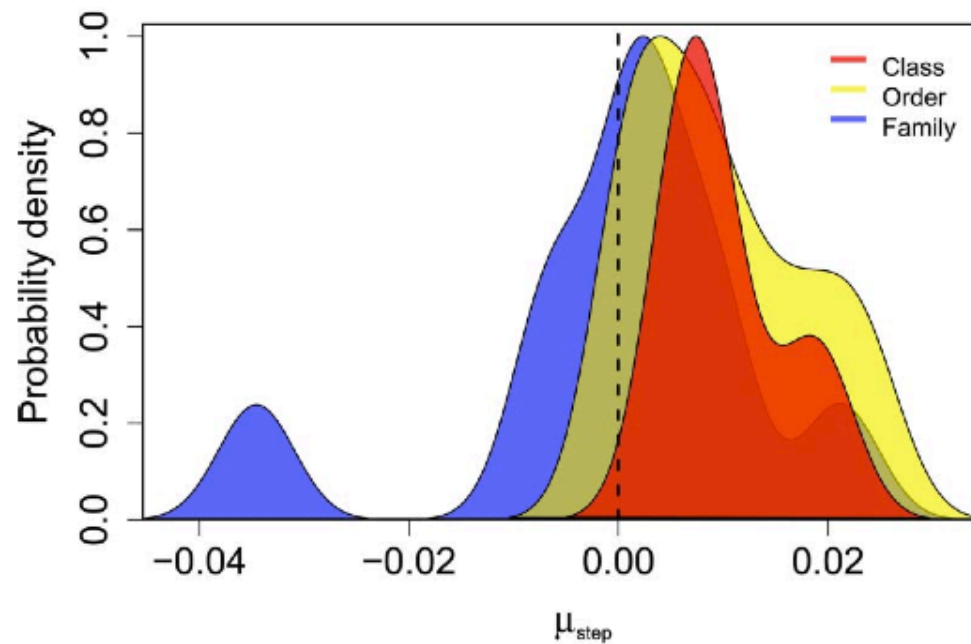


Fig. 3. Within-clade directionality parameter distributions within three hierarchical clade levels. The directionality parameter, μ_{step} , is the maximum-likelihood estimate for the mean rate of directional size change (\log_{10} ml/Myr) within a brachiopod clade. Large clades [classes ($n = 4$) and orders ($n = 11$)] all have statistically positive distributions consistent with Cope's rule, whereas small, constituent clades (families, $n = 10$) are indistinguishable statistically from zero tendency (*SI Appendix, Table 5*). Distributions were estimated by using Gaussian kernel density estimation with shared bandwidth (0.00361); maximum-likelihood estimates are available in *SI Appendix, Table 3*. Similarly distinct distributions occur in the joint directionality parameters for each clade level and when the parameters for DRW, URW, and stasis models are combined by using multimodel inference (23, 24).

Predict evolutionary
trends.

What evidence is
there for and against
them?