Using state space models to understand trait evolution in fossil lineages

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Resumen:

Paleontologists have long used repeated observations from fossil species to document and understand patterns of trait evolution. Here we describe a flexible framework for modeling such data called linear state space models. After summarizing this approach and its properties, we apply it to a classic dataset of trait evolution in species of diatom, a kind of unicellular algae. A set of models were fit to these diatom data using the state space approach, the best supported of which involved a novel model in which the focal trait tracks variations in solar insolation over time. Overall, state space models offer a useful framework for paleontologists to robustly develop, fit, and evaluate models of trait evolution.

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Linear state space models provide a useful framework for investigating phenotypic evolution in fossil lineages in a wide variety of models including Brownian motion, Ornstein-Uhlenbeck processes, and models that incorporate potentially explanatory environmental covariates. A state space framework also provides access to residuals for the predicted and observed values at each time point as well as improved numerical stability. We illustrate the value of

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the state space approach by re-analyzing a classic dataset of diatom evolution in Yellowstone Lake. We find that number of spines is best explained by adaptation to changing solar insolation as an exogenous environmental covariate.

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