Comment on “Statistical Independence of Escalatory Ecological Trends in Phanerozoic Marine Invertebrates”

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Madin et al. (Reports, 12 May 2006, p. 897) reported that escalation has not been an important cause of biological change throughout the history of life. However, they evaluated the escalation hypothesis with inappropriate data. First, global-scale data integrate heterogeneous signals that obscure the economic context of life. Second, diversity data cannot yield information about selection and adaptation.

Madin et al. (1) presented evidence from a global analysis of diversity and abundance of fossil invertebrates that escalation, or enemy-directed evolution, has not been an important causal driver of biological change throughout the history of life. The authors set up their paper by stating that escalation—fundamentally a hypothesis of adaptation of organisms to their enemies (2)—needs “to be tested by examining trends in relative diversity and counts of occurrences … among marine metazoans as a whole (p. 897).” However, this philosophical approach, which has dominated the field of paleobiology over the past 30 years, comes up short of testing the escalation hypothesis because it combines information from an immense array of clades, ecosystems, selection regimes, and geographic regions.

First, the global scale is too large to be relevant to the lives of organisms. The hypothesis of escalation has to be tested at a spatial scale equivalent to the scale of interaction among the units in which selection operates (2). The context—environment, interaction, functional role, adaptive syndrome, and geographic origin—in which organisms live and evolve varies dramatically from place to place and over time, making any global analysis an amalgam that integrates heterogeneous signals. Tests of the escalation hypothesis therefore must be conducted at local to regional scales so that emergent heterogeneity at the global scale does not mask the economic interactions of relevant evolutionary individuals.

By ignoring the context of life, global analyses inevitably obscure the economic processes that account for the historical patterns we are trying to explain.

Second, when we consider the character of selection as a causal economic process, it becomes evident that analyses of diversity patterns through time cannot yield biologically meaningful information about adaptation. Diversity reflects adaptation (the ecological and evolutionary effects of competition, cooperation, and predation, among other ways of acquiring or retaining the same locally limiting resources), but it cannot serve as a surrogate for it. Evolutionary units do not live or evolve as independent entities (2). At all scales of economic life, from the cell to ecosystems, entities create, and are affected by, an economic system of responsive, interacting entities. Diversity is not a measure of any biological interaction; it is an abstract number that incorporates a multitude of processes in addition to economic interactions among individuals. Results based exclusively on diversity patterns—abstract epiphenomena devoid of the context of life—are therefore incomplete tests of the escalation hypothesis and prone to be misleading.

An understanding of the role of competition in the history of life can come only from studies of the interacting economic units themselves and the local and regional environments in which they are embedded.

References and Notes


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