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Ecologists receive mixed news from fossil record

April 2, 2010

Paleontologists can't always get what they want, to paraphrase the Rolling Stones, but sometimes they can get what they need, according to a study that will appear in the May issue of the *American Naturalist*.

The fossil record captures both the broad sweep of evolutionary changes in life on earth as well as ecological responses to shorter-term local and regional environmental shifts. And yet the amount of variability seen among successive fossil assemblages tends to be low compared to that ecologists see over shorter time periods. This suggests that communities are extremely resilient or resistant to change over decades to centuries.

In the *American Naturalist* article, University of Chicago paleontologists [Adam Tomašových](#) and [Susan Kidwell](#) used data on living and fossil communities to explore where the low variability in fossil assemblages comes from. Does it come from the natural "time averaging" of skeletal remains that occurs during postmortem accumulation, or from biological processes actively maintaining a particular community composition?

Processes in the latter category include strong species preferences for particular niches that may enable them to avoid extinction owing to high growth rates at small population sizes, or the buffering of population growth during unfavorable times.

On most seafloors, lake bottoms and land surfaces, however, sediment accumulates quite slowly compared to the rates at which local animal populations generate skeletal remains. Multiple generations of skeletal remains may therefore become mixed within a single fossil assemblage. "Samples from a series of such time-averaged fossil assemblages are thus very different from the snapshots that come from repeatedly sampling a living community," said Tomašových, a postdoctoral scientist in [Geophysical Sciences at UChicago](#).

Simulating the effects of time-averaging on living communities from a Texas lagoon and an east African lake, Tomašových and Kidwell, the William Rainey Harper Professor in Geophysical Sciences, found that low temporal variation in species composition can be produced or reinforced by time averaging alone. Typical paleoecological data will thus seem to support models of local community stability, whether those communities have actually been stable.

"Fossil assemblages are, in most cases, the only source of information about past ecosystems unaffected by human disturbance," Tomašových said, "and so it is important that we evaluate all factors that might affect their ability to record rates of change. Post-mortem processes that might bias assemblages toward under-estimating past variability are especially important."

On the positive side, Tomašových and Kidwell note that although many fossil assemblages will be too time-averaged to discriminate variability generated by biological processes operating at small spatial scales (approximately a meter) —such as competition or predation-prey interactions—they excel at capturing the larger picture, such as the identities and relative abundances of species in the regional diversity pool that local communities draw upon.

The composition of that pool is determined by speciation, extinction and biogeographic processes that are usually extremely challenging to measure using the limited spatial and temporal scope of conventional biological sampling. "It's a matter of scale," Kidwell said. "The fossil record can't give us everything we want at the fine scale, but for some questions, we can get what we need."

Citation: "The effects of temporal resolution on species turnover and on testing



University of Chicago's Susan Kidwell and Adam Tomašových examine collections of molluscs at the Smithsonian Institution. In a paper to appear in the May issue of *American Naturalist*, the paleontologists explore how the ecological information provided by fossil assemblages is determined by their process of accumulation. (*Bill Denison*)

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metacommunity models," Adam Tomašových and Susan Kidwell, The American Naturalist, May 2010.

Funding: National Science Foundation and the National Oceanic and Atmospheric Administration's Sea Grant program.

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