Evolutionary mode routinely varies amongst morphological traits within fossil species lineages

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What happens when the modern evolutionary theory of punctuated equilibrium collides with the older theory of mosaic evolution? Part of the answer comes from a new, wide-ranging study by paleobiologists Melanie J Hopkins at the Museum fuer Naturkunde Berlin and Scott Lidgard at the Field Museum in Chicago. Their results are published this week in the Proceedings of the National Academy of Sciences (*PNAS*).

While processes of evolution are largely studied by observation and experiment in the living world, evolutionary tempo and mode – rates and patterns of change, respectively – are mostly revealed by studying the fossil record. Paleontologists measure parts of the hard skeletal fossil remains of once-living organisms that they believe best represent the morphology, or form, of those organisms. They then analyze the variation in these traits through successive layers of rock that were laid down over longs spans of geologic time in order to determine the tempo and mode of species evolution. Punctuated equilibrium postulates that most evolutionary change takes place in relatively short periods of time during the origination of new species, while species themselves mostly undergo stasis, or little change, over longer periods. Several recent

studies have indicated that stasis is much more common than gradual directional change in the fossil record. Mosaic evolution, on the other hand, is the tendency for different parts within species to evolve in different ways or at different rates.

The new study is based on data taken from hundreds of sequences of fossil samples previously reported in the scientific literature, but uses model selection methods available only in the last several years. The researchers compared models describing different modes of change, namely stasis, random change, and directional change, to each fossil series and found that different traits generally showed different, conflicting evolutionary modes within the same species.

Many kinds of life were represented, including mammals, fish, mollusks, arthropods, and single-celled organisms. This large comparative study validates the ubiquity of mosaic evolution. However, it also raises questions about the evidence for different evolutionary modes, since the great majority of previous studies that quantify stasis, punctuated equilibrium, and gradual or "random" patterns in the fossil record are based on measurements of single traits, not on combined analyses of many traits.

Further research will be required to establish the underlying processes driving the patterns of mosaic evolution and fossil species change. Nonetheless, the study is an excellent example of an emerging revolution in scientific inquiry as new techniques are used to breathe new life into old data.

More information: "Evolutionary mode routinely varies amongst morphological traits within fossil species lineages," *PNAS*, 2012.

Provided by Field Museum