Readings of the Fossil Record

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STEPPING STONES ACROSS THE GAPS

A significant gap in the fossil record has been filled recently by the discovery of two types of primitive flatfish from the Eocene epoch of Europe (50 million years ago). Matt Friedman, a graduate student at the University of Chicago and research associate at the Field Museum, has searched museum collections in England, France, Italy, and Austria and found specimens of two genera, one new and one reclassified. His study is published in the 10 July issue of *Nature*.

Adult flatfish have adapted to lying sideways on the ocean floor, waiting to ambush prey, by having both eyes on one side of their head. They begin life as symmetrical beings, but as larvae metamorphose into juveniles, one of their eyes migrates across their head to the other side. It's an extraordinary adaptation that has been difficult to explain, particularly by means of a gradual, continuous series of microevolutionary changes. Fossils of transitional forms with intermediate stages of orbital migration had not been found, nor were they expected to be. What would be the selective advantage of a partially migrated eye?

Friedman describes a new genus, *Heteronectes,* he found in the collection of the Naturhistorisches Museum in Vienna. Although its skull is highly asymmetrical, the orbits remain on opposite sides of the head in the adult. He also determined that another genus, *Amphistium,* once thought to have symmetrical skulls in fact did not, though orbits also remain on opposite sides of the dorsal midline. Unlike modern flatfish taxa, whose eyes typically migrate to one side or the other, *Amphistium* has both right-eyed and left-eyed forms. The asymmetry is clearly anatomical, and not the result of deformation as a specimen decays, because multiple specimens show the same skull morphology.

Flatfish have been held up as an example of a rapid, discontinuous evolutionary leap, and even as an argument against Darwinian evolution. The way such dramatic morphological shifts are thought to arise is by mutations that are expressed at an early stage of development. But what *is* the selective advantage of a partially migrated eye? The answer can be found in the behavior of living flatfish relatives that use their fins to prop themselves at an angle to the sea floor.

This strategy was a successful one, judging by the range of geologic time the primitive flatfish persisted: "*Amphistium* is known from two sites that are separated by a few million years in age," Friedman says, "so that sets a bare minimum." The primitive forms, he adds, also are found in deposits that contained completely asymmetrical modern forms, demonstrating that *Ampistium* and *Heteronectes* were reasonably good at what they did.

SEA CHANGES IN MARINE LIFE

Few events in Earth's history are as compelling as mass extinctions, and yet their causes remain a mystery. There is even doubt about the exact role of the one event that inspires the most morbid fascination: the Earth–asteroid collision at the end of the Cretaceous. Precipitating events may not be evident, but the rock record holds other clues to these massive die-offs. Shanan Peters, a University of Wisconsin–Madison geologist, has analyzed genus-level extinctions of marine animals and concluded that environmental changes related to sea level are clearly linked to the main extinction events of the Phanerozoic Eon (the last half-billion years). His work was published online on 15 June by *Nature.*

Peters used the work of the late Jack Sepkoski, a University of Chicago paleontologist who compiled stratigraphic ranges of more than 37,000 fossil marine genera into a global compendium. Sepkoski may be best known for identifying three evolutionary faunas: Cambrian, Paleozoic, and modern. To understand major trends in faunal composition within the Phanerozoic Eon, Peters tracked extinction rates of Sepkoski's Paleozoic and modern evolutionary faunas, and to measure how marine environments changed over time, he compiled the durations of marine sedimentary rock packages.

The two types of sedimentary rock Peters analyzed reflect two marine environments on continental shelves. One derives from precipitation of calcium carbonate (carbonates) produced by calcareous organisms and inorganic processes. The other derives from silicon-rich fluvial sediments (siliciclastics) produced by land erosion. The Paleozoic evolutionary fauna occurs predominantly in carbonate environments, where substrates are hard and nutrients low; the modern evolutionary fauna occurs predominantly in siliciclastic environments, where substrates are soft and nutrients high. Peters showed that changes in these two shelf environments consistently predicted the extinction patterns of their corresponding faunas, even when the faunas were out of sync.

The extinction of marine animal genera throughout the Phanerozoic clearly follows the dynamics of the changing shelf environment. Shifts from carbonate to siliciclastic environments, many of which occur during sea-level changes and perturbations to global climate, are good predictors of extinction events large and small. This suggests that there may have been a common suite of mechanisms at work in all mass extinctions, big-impact craters notwithstanding.

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