Oldest Complex Organic Molecules Found in Ancient Fossils

Fossils of sea creatures known as crinoids, which lived 350 million years ago. Photo by Kevin Fitzsimons, courtesy of Ohio State University

Ohio State University geologists have isolated complex organic molecules from 350-million-year-old fossil sea creatures -- the oldest such molecules yet found. The molecules may have functioned as pigments, but the study offers a much bigger finding: an entirely new way to track how species evolved.

Christina O'Malley, a doctoral student in earth sciences at Ohio State, found orange and yellow organic molecules inside the fossilized remains of several species of sea creatures known as crinoids. The oldest fossils in the study date back to the Mississippian period.

She reported the find Wednesday at the meeting of the Geological Society of America in Philadelphia.

Crinoids still exist today. Though they resemble plants, they are marine animals. They cling to the seafloor and feast on plankton that float by.

The crinoids in this study had flower-like fronds capping skinny stalks about six inches high -- a look resembling "starfish on a stick," said William Ausich, professor of earth sciences and O'Malley's co-advisor with Yu-Ping Chin, also a professor of earth sciences.

Today's crinoids display a range of colors, some variegated shades of red, orange, and yellow, so the geologists weren't surprised that some of those colors turned up in the 350-million-year-old crinoids, Ausich said.

"People have suspected for a long time that organic molecules could be found inside fossils," he added. "This is just the first time that scientists have succeeded in finding them."

Though the organic molecules could be classified as pigments, nobody can be sure that they functioned as pigments inside these ancient animals, the geologists emphasized. They may have served some other purpose besides coloration -- perhaps to defend the animal from predators by making it less palatable.

Because the molecules appear to be a little different for each species of crinoid, scientists can now use the pigments as biomarkers to map relationships on the creatures' family tree. Until now, they could only infer crinoid lineage based on the size and shape of key features on the animals' skeletons.

"This could be a new tool for figuring out how long-dead creatures became so prolific and successful. We can’t travel back in time, but now we can look for clues about these creature’s lives in a way that hasn’t been attempted or taken advantage of before," O'Malley said.

Scientists can only view fossilized plants and animals in the grays and tans of sedimentary rock, such as the limestone fossils in this study. Rock is inorganic, and replaces organic molecules such as pigments during fossilization. What O'Malley and her colleagues discovered is that some organic molecules occasionally survive the process.

"Crinoid skeleton is very porous, and we think that when inorganic molecules filled in the spaces of the skeleton during preservation, some of the organic molecules were trapped inside the fossil," she said.

O'Malley found pigments in every crinoid specimen that she sampled from three fossil sites, one in Switzerland and two in Indiana.

The Indiana samples date back to 350 million years ago, during the Mississippian period, when much of North America was covered by a shallow inland sea. The Switzerland fossils date back to 60 million years ago, during the Jurassic period. The sites preserved the crinoids exceptionally well, probably because a sudden storm buried them in sediment.

Should pigments be found in other fossils, the technique could prove to be a reliable way to trace species' evolution. So far, the crinoid biomarkers mesh well with scientists' concepts of how those species are related.

O'Malley isolated the pigments by grinding up small bits of fossil and dissolving the organic molecules into a solution. Then she injected a tiny sample of the solution into a machine called a gas chromatograph mass spectrometer. The machine vaporized the solution so that a magnet could separate individual molecules based on electric charge and mass. Computer software then identified the molecules.

Orange and yellow organic molecules emerged, along with several other molecules that the geologists have yet to identify. The off-the-shelf software was only designed to identify common laboratory compounds, O'Malley explained. She would like to generate her own database of fossil organic molecules, and also extract pigments from other marine fossils, including some from sites in Iowa.

Source: Ohio State University