RETHINKING WHAT CAUSED THE LAST MASS EXTINCTION

By JOHN NOBLE WILFORD
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Ken Kostel/American Museum of Natural History
SURVIVORS Fossilized remains of ammonites from Monmouth County, N.J.

FREEHOLD, N.J.—Splashing through a shallow creek in suburban New Jersey, the paleontologists stepped back 65 million years to the time of the last mass extinction, the one notable for the demise of the dinosaurs.

The stream flows over sediment laid down toward the end of geology's Cretaceous period. The clay at water level holds meaningful traces of iridium, the element more common in asteroids and other extraterrestrial objects than in the earth. No one could resist sticking a finger to the clay, treating it as a touchstone of their time travel.

Scientists associate the iridium anomaly with the asteroid impact or impacts thought to have set off the extinctions. The thin layer, which has been detected worldwide, is also considered the marker for the end of the Cretaceous and beginning of the Tertiary period, known as the K-T boundary.

At the time, sea levels were higher and New Jersey was warmer. The proto-Atlantic waters reached the center of the current boundaries of New Jersey, standing more than 60 feet deep here, where on a recent day the paleontologists were up to their ankles in a creek. They had their eyes on the sediments in the bank just above the iridium clay. They call this the Pinna layer.

On previous visits, they had found in the Pinna rock and soil a surprising number of marine fossils, including small clams, crabs and sea urchins. There was an abundance of

ammonites, considered index organisms of the uppermost Cretaceous environment. Somehow, here at least, life appeared to have not only persisted but also flourished for tens, perhaps hundreds, of years after the putative asteroid impact.

“This is really putting New Jersey on the map of the K-T boundary,” said Neil H. Landman, an invertebrate paleontologist at the American Museum of Natural History who is directing the new research in the Manasquan River basin.

The discovery of thriving communities of survivors at the end of the Cretaceous is giving some scientists second thoughts about the extinction’s causes and effects. Some question the conventional explanation of a single large impact that enveloped Earth in a cloud of dust and almost instantaneously brought on a deadly global winter. They contend that this may be an oversimplification, and that the real story behind the dinosaur-ending disaster is more complicated and as yet unclear.

“It is undeniable that the iridium spike at the base of the Pinna layer was produced by the impact,” Dr. Landman said. “That’s amazing and makes it hard to explain the ammonite abundances we find above the iridium anomaly.”

Gerta Keller, a paleontologist and professor of geosciences at Princeton University, said the research by Dr. Landman’s group “shows the complexity of this extinction event and the difficulty explaining it by the currently popular impact theory.”

Dr. Keller, who had no part in the New Jersey discovery, has investigated the K-T boundary in Brazil, Mexico and Texas, finding evidence that she says indicates multiple asteroid impacts occurring at the end of the Cretaceous. She reported that the one that gouged out the Chicxulub crater at the tip of Mexico”s *Yucatán* Peninsula, which had been the prime suspect in the extinction, struck at least 300,000 years before the dinosaurs died out.

At a meeting of the Geological Society of America last week, Dr. Keller reported marine fossil evidence that she said linked the mass extinction to widespread volcanic eruptions that swept India at the end of the Cretaceous.

In other words, the world’s ecosystem was under widespread stress for an extended time. The extinctions might have had multiple causes, not the single asteroid impact and almost instant death as hypothesized in 1980 after the detection of the global iridium layer.

At first, the paleontologists treated the fossil discoveries in New Jersey with caution. Geologists who analyzed 37 samples of sediment from three sites at the creek and elsewhere in the basin concluded that they contained a telling concentration of iridium at the Pinna base. Still, Dr. Landman thought it possible that the iridium had shifted over time, confusing the chronology.

Dr. Landman said he had since become increasingly confident that the iridium layer at the creek remained where it was deposited. It is presumably a true marker of an asteroid impact with global repercussions, and this further complicates understanding of the mass extinction. Why is there no evidence at the creek for the almost immediate post-impact destruction, as assumed by the standard theory?

A construction project led scientists to the discovery. Excavations for a new bridge three years ago exposed a section of rock spanning the K-T boundary. In a report this year, Dr. Landman's group wrote that the section contained "the most abundant and diverse invertebrate assemblage ever discovered from this interval in New Jersey."

The first investigations, beginning with Ralph O. Johnson, a mostly self-educated but expert paleontologist who lives in West Long Branch, uncovered traces of the fossil-rich stratum reaching to the undisturbed outcrops along this creek. The stream has no name on maps, but the scientists, thinking of the prickling briars and entangling wild grape vines, call it Agony Creek.

"You don't have to go to Mongolia to discover important fossils," Mr. Johnson said. "These outcrops sit in the middle of the suburbs, two and a half miles from my home. How could they have been missed until now?"

Wading downstream, Dr. Landman, Mr. Johnson and Matthew P. Garb, a doctoral student in geology at Brooklyn College, came to a place that looked good for prospecting. Wet and dirty, they got to work—grown men squatting at the edge of a creek, making mud pies, or so it appeared.

In fact, they were cutting out wedges of the Pinna layer and, wielding picks, knives and brushes, were extracting and examining the remains of presumed survivors in the aftermath of the K-T mass extinction.

At least 110 species of near-shore marine organisms have been identified in the Pinna layer, Dr. Landman explained. This was a robust community that lived over a geologically short period of time, perhaps several tens of years. But the Pinna is truncated at the top, which the scientists said implied a still longer duration amounting to hundreds of years.

Later, back at his museum laboratory in Manhattan, Dr. Landman pulled out trays of ammonites, his scientific specialty. These organisms first appeared in the Devonian period, about 410 million years ago; there were 30 known species at the end of the Cretaceous, and after the extinctions, there were none. Their near-relative the nautilus survives, perhaps because it is a scavenger that will eat just about anything.

The trays held a collection of the creek specimens. Ten ammonite species were recovered from the presumably post-impact Pinna layer. One of them, *Discoscaphites jerseyensis*, is unique to New Jersey.

After the event producing the iridium residue, and the occurrence of any accompanying disasters, Dr. Landman said, the extinctions were not immediate everywhere, certainly not among marine organisms off New Jersey.

“This is what I imagine happening,” he said. “Storms of biblical proportions and a heavy discharge of river floods might have buried sediments rapidly. These marine communities may have flourished immediately afterward as a result of a lot of organic material, such as plankton, dying and settling to the depths for their consumption.”

A few other paleontologists have also cast doubt on the timing and single-impact suddenness of the mass extinction. The idea of a killer impact that became the standard theory was proposed in 1980 on the basis of iridium traces; it gained wide acceptance after the discovery in 1991 of the impact crater in Mexico. But in some places, the fossil record for dinosaurs seems to disappear a little before the iridium is deposited. Geologists have found several other crater remnants that could have been gouged out by asteroids and also the suspect volcanoes of India.

Dr. Landman said he was not sure how long the ammonites in New Jersey lived above the iridium marker, but they “could not possibly have survived 300,000 years,” as Dr. Heller of Princeton argues.

At the creek site, above the fossils of the Pinna layer, the Hornerstown Formation preserves a record of impoverished life, beginning a few hundred years after the extinction event or events. There were tiny oyster shells from a single species, and little else.