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EMBARGOED UNTIL 1 PM CDT JUNE 25, COINCIDING WITH PUBLICATION IN THE JOURNAL *SCIENCE*

New Fossils Upend Narrative that Flowering Plants Developed Large Seeds and Fruits Only After Dinosaur Extinction

A "botanical Pompeii" shows that a diverse forest of flowering plants contained large seeds and fruits more than 10 million years earlier than previously known

An artistic reconstruction of the understory of a late Cretaceous forest based on 75-million-year-old fossils from an inland environment that is now part of New Mexico. Illustration by Brian Engh.

Link to Media Kit

Dallas, TX (June 25, 2026) — A unique cache of plant fossils from volcanic deposits in New Mexico contradicts the common narrative that flowering plants, which now dominate the earth's flora, had more limited roles in the ecology of Earth's forests before dinosaurs disappeared 66 million years ago. New research shows surprisingly large seeds and fleshy fruits in a dense flowering-plant dominated forest, preserved in a "botanical Pompeii" that happened nearly 10 million years before a catastrophic asteroid impact wiped out the dinosaurs. The discovery was made by a multi-institutional team of scientists, led by UC Berkeley doctoral student Jaemin Lee and includes critical work by Perot Museum of Nature and Science's Director of Paleontology & Curator of Paleobotany and co-author Dr. Dori L. Contreras that began during her doctoral work at the university.

"Contributing to the body of science is a critical pillar of the work we do at the Perot Museum of Nature and Science. Discoveries Dr. Contreras made while pursuing her doctoral degree at UC Berkeley have led in part to this paradigm shift in how we think of the ecology of angiosperms in

the Late Cretaceous period," stated Dr. Linda Silver, Eugene McDermott chief executive officer of the Perot Museum. "Dr. Contreras's ongoing work at the Perot Museum examining the palaeobotanical finds in New Mexico will further contribute to our understanding of the history and evolution of Earth."

The new discovery calls into question long-held narratives about the evolution of flowering plants' fruits and seeds and how flowering plants, called angiosperms, contributed to Cretaceous forests. Flowering plants appeared 135 million years ago during the Cretaceous and quickly diversified and spread across the globe. However, many of the features of flowering plants that we know today — like their big fruits, forming all layers of dense forests — are thought to have evolved over a longer period of time, only becoming like modern forms after the extinction of the dinosaurs.

"Our results show that, at least in some hot and humid environments during the Late Cretaceous, well before the extinction boundary by 10 million years, angiosperms were already investing more resources into individual diaspores and forming dense forests," said the lead author and UC Berkeley doctoral student Jaemin Lee.

The team of scientists reconstructed an ancient fossilized forest that includes large-trunked flowering trees, such as laurel relatives and palms, and a great diversity of other flowering plants, growing alongside more ancient lineages of ferns and redwoods. Unlike other Cretaceous floras where angiosperm diaspore size, on average, were comparable to a poppy seed, the average diaspore size in this fossil forest is comparable to a large blueberry, showing over a hundredfold increase in volume.

"This may not sound that big," Lee said, "but the large fruits we eat today are the result of centuries of selective breeding. Wild watermelons, for example, were only 5 centimeters (2 inches) wide."

The New Mexico site is unique in capturing an ancient environment at a single moment in time, when a volcanic ashfall buried an inland forest. Most other fossil plant sites consist of material that ended up in lake, river or coastal sediments, which are conducive to fossilization but often represent a mashup of material from different times and habitats.

"You can think of it as like a botanical Pompeii, where ashfall deposits preserve everything in position and we can reconstruct the forest structure" Lee said. "These diaspores are preserved together with various leaves and flowers, brought from the canopy down to the forest floor, by the ashfall."

The solidified ash deposit, referred to as Dori's tuff, is about three-quarters of a mile long and part of the Jose Creek Formation in New Mexico. When the ash was deposited after a nearby volcanic eruption, the site was about 124 miles west of the coast of the Western Interior Seaway, which at the time divided eastern from western North America. The forest at that time was situated in the mid-latitudes, though the Earth was much warmer then and the site more closely resembled a tropical forest.

"This site provided a unique opportunity because in addition to being a snapshot in time, the rock layer containing the fossil flora also was exposed over a really long distance. As a result, we were able to sample it in a way that allowed us to understand what the plant community was like across a large portion of the landscape, rather than just one spot," stated Dr. Contreras. "In essence, we took an almost mile walk through a buried forest, dug up the plants along the way and pieced together what lived where. The seeds and fruits we collected from those plants

along the way led to the questions underpinning this study about the reproductive ecology in the Cretaceous."

Angiosperms now dominate Earth's flora and comprise all the food we eat, from staple grains and spices to squashes and avocados. What we refer to as fruits, grains, and nuts, biologists call diaspores: the seed(s) and associated structures that help the seeds disperse. Their size gives an idea of the ecological strategies of plants. Numerous, tiny poppy seeds, for example, are dispersed unassisted or by wind after they are released. On the other hand, producers of many large fleshy fruits, like peaches, invest a huge amount of resources per dispersed seed and often require large animals, such as humans, to spread them.

Today, angiosperm diaspore size ranges from tiny, dust-like orchid seeds that are only a few micrometers across and lack nutrient reserves, to the giant double coconut, a palm fruit that weighs up to 55 pounds. The greater the investment from the parent plant, the higher the chance of seedling survival and dispersal.

"This is the first record of pretty sizable fruits and seeds at the assemblage level, with a total of nearly 80 distinct types including several forms reaching about an inch in length, in the Cretaceous. This suggests that plant-animal interactions and the formation of angiosperm-dominated dense forests likely evolved before the end-Cretaceous extinction and subsequent ecological restructuring," Lee said.

"That animals were eating large fleshy diaspores during that time is not a surprise because other seed plants, such as ginkgos, were already producing them and had been for a very long time," Cindy Looy, a Berkeley professor of integrative biology and curator in the UC Museum of Paleontology, said. "This fossil flora suggests that these animals were already moving over to eating bigger seeds produced by angiosperms 75 million years ago. This is a surprise, because people thought they didn't exist yet. And here they are."

While dinosaurs — including a large *Tyrannosaurus* species — have been found in the area, Dori's tuff is best known for its abundant fossilized plants. Contreras, during her time as a doctoral student with Looy, conducted extensive excavations at more than two dozen quarry sites within the tuff, digging up thousands of fossilized leaves, fruits and flowers. Currently, Contreras is finalizing her analysis of the forest's structure from the leaves, many from plants that are now extinct.

"The scale of the sampling and the novelty of the flora's environment compared to other North American fossil floras undoubtedly combined to allow these new insights into old questions," said Contreras. "The forest was located more south and inland than other floras studied from North America, in what was a more tropical climate. We're getting a window into a habitat we haven't been able to see in such great detail until now, and we are seeing surprising levels of flowering plant diversity and ecologies in this complex forest."

Co-author Garland Upchurch of the University of Colorado Museum of Natural History in Boulder has also excavated at the site and is leading an analysis of the wood fossils, which include some of the largest Cretaceous angiosperm trunks known to date. Lee, who studies animal-plant interactions, focused on the diaspores in these deposits.

"We still don't know what drove the initial rise in angiosperm diaspore size," Lee added. "It was probably multifaceted ecological factors, and different groups of angiosperms may have developed larger diaspores for different reasons. But at least now we know that it wasn't the end-Cretaceous extinction and the following emergence of more modern groups of frugivores

that led to the diversification of angiosperm reproductive strategies. It coincided with the broader Late Cretaceous ecological radiation of flowering plants. This gives us a new view of the evolutionary ecology of angiosperms that represent 90% of today's land plants, and their potential ecological interactions with animals before the age of the mammals."

Ongoing work from the team on the thousands of fossils from the site that are curated in the collections of UC Museum of Paleontology and the Perot Museum will continue to reveal new aspects to the rise of flowering plants and the development of modern forests.

Lead author is Jaemin Lee. Co-authors are Dori L. Contreras; Cindy V. Looy; James G. Saulsbury of the University of Kansas in Lawrence, a former Berkeley undergrad; and Garland R, Upchurch. The research is funded by the National Science Foundation (DEB 1655973 and 16655985) and the UC Museum of Paleontology.

Image: *The scene depicts two hypothetical examples of dispersers of large flowering plant (angiosperm) seeds before the dinosaurs disappeared 66 million years ago. Shown are an early mammal (left) — a member of a now-extinct group of rodent-like animals called multituberculates — and a marginocephalian dinosaur (top) among angiosperms and ferns. (Image credit: Brian Engh, livingrelicproductions.com)*

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About the Perot Museum of Nature and Science

Located in the heart of Dallas, Texas, the Perot Museum of Nature and Science is a nonprofit educational and research organization dedicated to inspiring minds through nature and science. Visitors will find everything from dinosaurs to diamonds and space to sports, packed into five levels of hands-on discovery and adventure. Through its state-of-the-art exhibits, educational programming and community outreach, the Museum offers exciting and innovative experiences for learners of all ages. For more information, visit perotmuseum.org.

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