A fossil fruit from California shows ancestors of coffee and potatoes survived cataclysm that killed the dinosaurs

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Image of fruit belonging to Palaeophytocrene chicoensis. The Sierra College Museum of Natural History is the permanent repository for this fossil. Credit: Brian Atkinson

The discovery of an 80-million-year-old fossil plant pushes back the known origins of lamiids to the Cretaceous, extending the record of nearly 40,000 species of flowering plants including modern-day staple crops like coffee, tomatoes, potatoes and mint.

Brian Atkinson, assistant professor of ecology & evolutionary biology at the University of Kansas and curator of paleobotany at the KU Biodiversity Institute, recently published a study of the fossil plant, named Palaeophytocrene chicoensis, in the journal *Nature Plants*.

"This fossil tells us a really diverse group of flowering plants evolved prior to our original understanding," Atkinson said.

"The fossil belongs to a group of lianas, which are woody vines that add structural complexity to rainforests. It shows us this group of flowering plants appeared super early in the fossil record. There'd been some hypotheses that they were around in the Cretaceous period—but no good clear evidence. This is a great indicator that structurally complex, modern-type rainforests may have been around as early as 80 million years ago."

According to the KU researcher, the fossil fruit sheds new light on a "critical interval" in the history of life on Earth.

"It's a time when forests are transitioning from being dominated by gymnosperms such as conifers to being dominated by flowering plants," Atkinson said.

"We know these ecological transitions occurred during the Late Cretaceous—but we still need critical pieces of evidence, like how certain ecosystems formed, such as rainforests, which today comprise over half of plant species that are alive today. This fossil shows this diverse group of plants, the lamiids, were older than previously thought,

and Cretaceous ecosystems on the west coast of North America may have resembled structurally complex rainforests."

The well-preserved fossil was unearthed in the 1990s by construction crews building housing near Granite Bay in Sacramento, California. Located in deposits of the Chico Formation tied to the Campanian (fifth of six ages of the Late Cretaceous epoch), the fossil was collected by Richard Hilton and Patrick Antuzzi of Sierra College and housed at their natural history museum.

"I spent seven years looking for these things [Cretaceous lamiids], and I couldn't find them," Atkinson said. "I'd been collecting and studying Cretaceous plants on the West Coast to better understand the evolution of flowering plants. Somebody said, 'Oh, you should check out the Sierra College Museum of Natural History,' as it wasn't on my radar to contact them. They gladly had me over to look at their fossil plant collection, and I was just kind of blown away by the diversity of plants that these guys were able to dig up in this housing development."

It wasn't until Atkinson saw the fossil plant recovered decades earlier from the construction site that the specimen's potential significance was understood.

"As I was opening this drawer, I noticed this fruit with really striking patterns on its surface," the KU researcher said. "I immediately recognized it as belonging to this lamiid family called Icacinaceae, which is well-known in younger, post-Cretaceous deposits after the mass-extinction event. It's all over the place. But before, there are no clear known fossils that belong to that family. And I thought, 'Oh my God, this is it!' You know, this family of plants have just these really striking fruits."

To confirm his thinking about the fossil, Atkinson needed to take a

closer look. He studied the fossil fruit's structures using light microscopy, which allowed him to generate beautiful photographs of the specimen. By scrutinizing its arrangement of ridges, pits, rows and tubercles, the KU investigator could make comparisons to previously described fossils to place it correctly within its family tree. The work challenged Atkinson because he'd never described a "compression fossil" of its kind.

"I'm used to working on fossils that preserve in a different mode called 'permineralization,'" Atkinson said. "This is my first paper on a compression fossil, and it was a little bit nerve-wracking, working in a different preservation type than you're used to. Imaging it is a whole different process—I'm glad this turned out so well."

After placing the fossil plant within the genus Palaeophytocrene, Atkinson named the species chicoensis after the Chico Formation where it was found.

"I just named it after the formation it was recovered from," he said. "Part of my job is coming up with scientific names for new species that I describe, but I'm not that creative about it—usually I look up the location where it was discovered. Has that name been taken already?"

If the fossil fruit's name is humdrum, it's significance isn't. The KU researcher said the findings help establish that one of the most diverse flowering plant groups survived the cataclysm that killed the dinosaurs to evolve into thousands of familiar modern species, including vital food crops for humanity.

"My research involves understanding deep time to better reconcile how modern biodiversity came to be—and potentially how it will fare in the future with climate change," said Atkinson.

"I've been trying to characterize these evolutionary events of flowering plants in the Cretaceous period, when the diversity of these plants just exploded. The Cretaceous record of lamiids has been hard to establish, but I knew these fossils had to be around. The West Coast of North America is under-sampled for Cretaceous plants compared to the Western Interior and East Coast of North America. By broadening our sampling geographically, we'll come across more and more plants to help us understand Cretaceous diversification that led to modern biodiversity."

More information: Brian A. Atkinson, Icacinaceae fossil provides evidence for a Cretaceous origin of the lamiids, *Nature Plants* (2022). DOI: 10.1038/s41477-022-01275-y

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