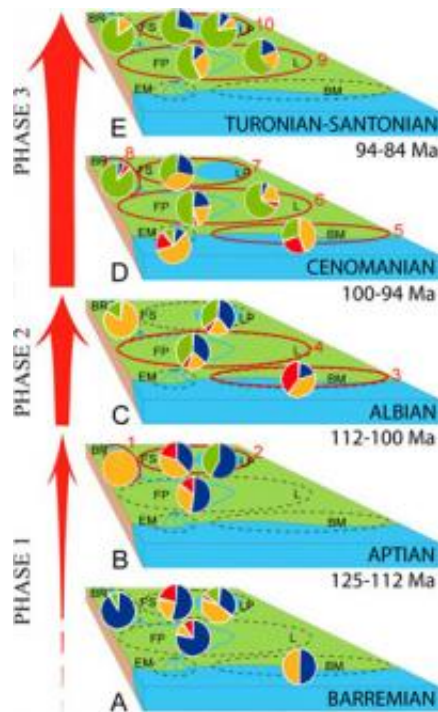


Research yields understanding of Darwin's 'abominable mystery'

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This figure shows the shift from ferns (blue), conifers (red) and other gymnosperms (orange) to angiosperms (green) in various aquatic environments between 130 million and 84 million years ago.

(Phys.org)—Research by Indiana University paleobotanist David L. Dilcher and colleagues in Europe sheds new light on what Charles Darwin famously called "an abominable mystery": the apparently sudden appearance and rapid spread of flowering plants in the fossil record.

Writing in the [Proceedings of the National Academy of Sciences](#), the researchers present a scenario in which [flowering plants](#), or [angiosperms](#), evolved and colonized various types of aquatic environments over about 45 million years in the early to middle Cretaceous Period.

Dilcher is professor emeritus at IU Bloomington in the departments of [geological science](#) and biology, both in the College of Arts and Sciences. Co-authors of the paper, published online this week, are Clément Coiffard of the Leibniz Institute for Evolution and Biodiversity Research in Berlin and Bernard Gomez and Véronique Daviero-Gomez of the National Center for Scientific Research in Lyon, France.

The paper draws on extensive fossil data from Europe, providing a comprehensive picture of how angiosperms evolved and connecting their evolution with changes in the physical and biological environments. Dilcher, who has studied the rise and spread of flowering plants for decades, said the scenario is consistent with findings from the fossil record in North America, including his own work showing that angiosperms occupied a variety of aquatic and near-[aquatic environments](#).

"This attention to the total picture of plant groups and the paleo-environment begins to form a pattern," Dilcher said. "We're able to turn the pages of time with a little more precision."

Darwin wrote to Joseph Dalton Hooker in 1879, about 20 years after the publication of "On the Origin of Species," that the rapid development of higher plants in recent geological times was "an abominable mystery." The issue has long preoccupied paleobotanists, with competing theories seeking to explain how angiosperms supplanted ferns and gymnosperms in many regions of the globe.

Dilcher and his colleagues show that angiosperms successfully invaded

certain environments, gradually spreading to others. They write that angiosperms migrated to new environments in three phases:

- Freshwater lake-related wetlands between 130 million and 125 million years ago
- Understory floodplains between 125 million and 100 million years ago
- Natural levees, back swamps and coastal swamps between 100 million and 84 million years ago

While paleobotanists once focused on collecting fossil flora and trying to make connections with present-day varieties, Dilcher and his colleagues have produced new insights into the evolutionary biology of flowering plants through close analysis of morphology and anatomy.

Dilcher added that co-evolution with insects gave angiosperms an evolutionary advantage. Insects played a vital role in cross-pollinating plants and accelerating the spread of genetic material. Plants evolved the means to "advertise themselves" with fragrances and bright colors while producing pollen and nectar that provided food for insects.

More information: www.pnas.org/content/early/2012/12/04/1218633110.full.pdf

Provided by Indiana University

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