Rapid burst of flowering plants set stage for other species

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A new University of Florida study based on DNA analysis from living flowering plants shows that the ancestors of most modern trees diversified extremely rapidly 90 million years ago, ultimately leading to the formation of forests that supported similar evolutionary bursts in animals and other plants.

This burst of speciation over a 5-million-year span was one of three major radiations of flowering plants, known as angiosperms. The study focuses on diversification in the rosid clade, a group with a common ancestor that now accounts for one-third of the world's flowering plants. The forests that resulted provided the habitat that supported later evolutionary diversifications for amphibians, ants, placental mammals and ferns.

"Shortly after the angiosperm-dominated forests diversified, we see this amazing diversification in other lineages, so they basically set the habitat for all kinds of new things to arise," said Pamela Soltis, study co-author and curator of molecular systematics and evolutionary genetics at UF's Florida Museum of Natural History. "Associated with some of the subsequent radiations is even the diversification of the primates."

The study appearing online in next week's *Proceedings of the National Academy of Sciences* is the first to show the evolutionary relationships of these plants and provide evidence for their rapid emergence and diversification.

Because the diversification happened so quickly, at least in evolutionary terms, molecular methods were needed to sort out the branches of the rosid clade's phylogenetic tree, a sort of family tree based on genetic relationships. Only after sequencing many thousands of DNA base pairs are genetic researchers able to tease apart the branches and better understand how plant species evolved.

Often, when scientists discuss the rapid radiation of flowering plants, they talk as if there had been one massive burst of early diversification, said Doug Soltis, co-author and chair of UF's botany department.

"I think one thing that becomes very clear from our phylogenetic trees when you look at them closely is that it's not just one big explosion of species within the flowering plants," Doug Soltis said. "There's a series of explosions."

The rosid clade's diversification is one of at least three bursts in the early evolution of flowering plants. More than 300,000 species of angiosperms exist, classified into an estimated 15,000 genera and more than 400 families. Understanding how these plants are related is a large undertaking that could help ecologists better understand which species are more vulnerable to environmental factors such as climate change.

"We really need to know on a finer scale how these species are related and on different parts of the planet how members of the clade are related," Doug Soltis said. "That's where the action is going to be in terms of how this clade responds to climate change. How members of this large clade respond is really going to determine the fate of most of the organisms on the planet."

The study's authors sequenced 25,000 base pairs of DNA and sampled a broad range of 104 species from the rosid clade. Using a phylogenetic tree to date the diversification of lineages requires the use of a molecular

clock, which calibrates the degree of change that has occurred over time.

"You can assume that over time DNA sequences accumulate change, and things that are more similar to each other in general would have diverged from each other more recently than things that are more different," Pam Soltis said.

But different genes have different rates of evolution, as do different clades. To compensate, the study used algorithms that accommodate the different rates. Rosid fossils selected by co-author Steven Manchester, the museum's curator of paleobotany, were used to help calibrate that clock by setting minimum ages for member species.

Source: University of Florida