Molecular study could push back angiosperm origins

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A new analysis of the land plant family tree suggests that flowering plants may have lived much earlier than previously thought. Credit: Wikimedia

Flowering plants may be considerably older than previously thought, says a new analysis of the plant family tree.

Previous studies suggest that flowering plants, or angiosperms, first arose 140 to 190 million years ago. Now, a paper to be published in the *Proceedings of the National Academy of Sciences* pushes back the age of angiosperms to 215 million years ago, some 25 to 75 million years earlier than either the fossil record or previous molecular studies suggest.

"If you just looked at the fossil record, you would say that angiosperms originated in the early Cretaceous or late Jurassic," said Michael

Donoghue of Yale University. "Most molecular divergence times have shown that they might be older than that," added Yale biologist Jeremy Beaulieu. "But we actually find that they might be Triassic in origin," said Beaulieu. "No one has found a result like that before."

If confirmed, the study could bolster the idea that early angiosperms promoted the rise of certain insects. Modern insects like bees and wasps rely on flowers for nectar and pollen. "The fossil record suggests that a lot of these insect groups originated before angiosperms appeared," said Stephen Smith of the National Evolutionary Synthesis Center. This study shifts the oldest angiosperms back farther in time towards the origin of groups like bees and flies, the scientists say. "If you take our dates and superimpose them on the evolutionary tree for these insect groups, all of a sudden you get a match," said Beaulieu.

To trace the origins of flowering plants, the researchers used genetic comparisons of living plants and clues from fossils to reconstruct the relationships among more than 150 terrestrial plant species. Though their results contradict previous age estimates for angiosperms, they support estimates for other plant groups. "Many of the dates that we get correspond really well to the known fossil record, at least for the origin of land plants and the origin of vascular plants and seed plants," said Donoghue. "But we got a much older date for the origin of angiosperms — one that's really out of whack with the fossil record," Smith added.

This disconnect between molecular and fossil estimates is not unheard of, the authors explained. "We see the same kind of discrepancy in other groups too, like mammals and birds," said Donoghue.

Why the mismatch between different approaches to dating the tree of life?

One possibility, the researchers explained, is that the first flowering

plants weren't diverse or abundant enough to leave their mark in the fossil record. "We would expect there to be a time lag between the time of origin and when they became abundant enough to get fossilized," said Smith. "The debate would just be how long."

"Imagine a long fuse burning and then KABOOM! There's a big explosion. Maybe angiosperms were in that fuse state," said Donoghue. "But it's hard to imagine flowering plants would have had a big impact on the origin of major insect groups if that were the case," he added.

Another possibility, the researchers allow, is that the molecular methods may be amiss. "If the angiosperms originated 215 million years ago, then why don't we find them in the fossil record for almost 80 million years?" said Beaulieu. "It could also suggest that our dates are wrong."

"We've done the best analysis we know how to do with the current tools and information," said Donoghue. To improve on previous studies, the researchers used a method that allows for variable rates of evolution across the plant family tree. "Rates of molecular evolution in plants seem to be correlated with changes in life history," he explained. "Older methods assume that rates of molecular evolution don't change too radically from one branch of the evolutionary tree to another. But this newer method can accommodate some fairly major rate shifts."
Although researchers have come up with some savvy statistical tricks to account for rate shifts, Donoghue explained, the problem hasn't entirely disappeared.

"As we develop better molecular methods, people would like it if the molecular dates reconciled with the fossil record. Then everybody would be happy," said Donoghue.
"But instead the gap is getting wider," he said. "And in the end, that might actually be interesting."

The team's findings will be published early online in the March 15 issue of Proceedings of the National Academy of Sciences.

More information: Smith, S., J. Beaulieu, and M. Donoghue. (2010). "An uncorrelated relaxed-clock analysis suggests an earlier origin for flowering plants." Proceedings of the National Academy of Sciences doi/10.1073/pnas.1001225107

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