Broad scale phylogeny of orchids reveals secrets of their diversity

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Orchid. Credit: Nicolas Perrault II/Wikipedia

(Phys.org)—An international team of researchers has conducted a broad scale phylogeny of orchids for the first time and in so doing have uncovered many of the reasons for their broad diversity. In their paper

published in *Proceedings of the Royal Society B*, the team outlines how they carried out their study and what they learned from it.

Orchids are incredibly diverse—the most diverse family of angiosperms—with over 25,000 species, which the researchers note is more than all the reptiles, birds and mammals combined. But how they came to be so diverse has been a matter of conjecture for many years. To finally answer that question, the researchers conducted a broad scale phylogeny (study of evolutionary development) by using newly developed gene sequencing methods. In all, they used 75 chloroplast genes from 39 species, which represented almost all of the major orchid groups. They also included 96 orchid relatives in the study and by also referencing data from fossils they were able create a family tree of sorts for orchids which included the rate of new species introduction.

In looking at their data, the team was able to see that orchids first came on the scene approximately 112 million years ago, and began splitting into different lineages approximately 20 million years later. They were also able to see that approximately 64 million years ago, the flowers developed a means for clumping their pollen into pollinia, which helped pollinators hold onto grains before visiting other orchids—one of three periods in their history defined by accelerated diversification. The others involved their migration to tropical mountain ranges and then changes that led to the attraction of new pollinators: orchid bees, moths and butterflies. The researchers noted that the development of species that were able to climb trees was pivotal in the evolution of new species as was the migration to tropical mountains. Both led to new species development due to different environmental conditions.

One puzzle still remains, however—why do so many orchid species (approximately a third) have deception mechanisms that serve to lure pollinators but do not appear to have been involved in increasing diversity? The researchers cannot answer that question, but suggest it

might be due to misidentification of some species.

More information: Orchid phylogenomics and multiple drivers of their extraordinary diversification, *Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2015.1553

Abstract
Orchids are the most diverse family of angiosperms, with over 25 000 species, more than mammals, birds and reptiles combined. Tests of hypotheses to account for such diversity have been stymied by the lack of a fully resolved broad-scale phylogeny. Here, we provide such a phylogeny, based on 75 chloroplast genes for 39 species representing all orchid subfamilies and 16 of 17 tribes, time-calibrated against 17 angiosperm fossils. A supermatrix analysis places an additional 144 species based on three plastid genes. Orchids appear to have arisen roughly 112 million years ago (Mya); the subfamilies Orchidoideae and Epidendroideae diverged from each other at the end of the Cretaceous; and the eight tribes and three previously unplaced subtribes of the upper epidendroids diverged rapidly from each other between 37.9 and 30.8 Mya. Orchids appear to have undergone one significant acceleration of net species diversification in the orchidoids, and two accelerations and one deceleration in the upper epidendroids. Consistent with theory, such accelerations were correlated with the evolution of pollinia, the epiphytic habit, CAM photosynthesis, tropical distribution (especially in extensive cordilleras), and pollination via Lepidoptera or euglossine bees. Deceit pollination appears to have elevated the number of orchid species by one-half but not via acceleration of the rate of net diversification. The highest rate of net species diversification within the orchids (0.382 sp sp−1 My−1) is 6.8 times that at the Asparagales crown.