The radiation of angiosperms led to the emergence of the vast majority of today’s plant species and major crops, and occurred in conjunction with the appearance of vessels. Vessels provided angiosperms a fitness advantage by supporting higher hydraulic efficiency, photosynthesis and productivity in the warmer late-Cretaceous. However, their evolutionary origin has remained largely a mystery. We recently discovered a previously unknown gene, ENLARGED VESSEL ELEMENT 1 (EVE1), which regulates vessel formation, vessel area and hydraulic conductivity. Higher expression of EVE1 results in an increase in the rate of photosynthesis and fitness under elevated air temperature and evaporative demand, similar to those that prevailed during the Cretaceous. In plants, EVE1 first emerged in streptophyte algae, but expanded dramatically among angiosperms. Other than in streptophytes, EVE1 is only found in the genomes of algae-infecting prasinoviruses, suggesting that the origin of one of angiosperms’ most evolutionarily important trait may reside in an ancient viral lateral gene transfer event. Vessels were one of many critical traits that shaped plant evolution – another was the development of symbiosis between certain angiosperms and nitrogen-fixing bacteria. This symbiosis allowed some species to thrive in nitrogen-deficient soils, occupying ecological niches that had been largely inaccessible. In the first part of the talk I will review our early work that uncovered EVE1, and describe our latest efforts to determine its cellular and molecular role. In the second part of my talk I will review the progress in a recently funded project aimed at uncovering the genomic novelty that led to the emergence of the nitrogen-fixing clade in angiosperms, and the effort to introduce this trait into major food crops.