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The evolution of assembly complexity in Rubisco.

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Rubisco is the central CO2 fixing enzyme of the Cavin cycle and responsible for the vast majority of all CO2 fixation on our planet today. In plants, Rubisco undergoes an elaborate set of steps involving the sequential action of at least 6 different dedicated folding and assembly chaperones to assemble into its enzymatically active form. This complexity evolved from much simpler Rubisco ancestors that functioned without any of these additional factors. In this talk I will summarize my lab's work on retracing the evolution of Rubisco's complex present-day assembly requirements. Using ancestral sequence reconstruction and the resurrection of billion-year-old Rubiscos, we are learning how this crucial enzyme gradually elaborated its structure and assembly mechanism. Some of these elaborations had history-changing effects on Rubisco's catalytic properties, whereas others appear to be evolutionary accidents that simply became impossible to lose. This work is beginning to illuminate key events in Rubisco's history leading up to and following the evolution of oxygenic photosynthesis, one of the most consequential events in the history of life on earth. It also raises the possibility of learning from evolution to re-simplify and improve the assemblies of agriculturally important Rubiscos.

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