What if Oxygenic Photosynthesis Isn't That Old?

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Oxygenic photosynthesis is the most important bioenergetic innovation in the history of our planet; while it is widely appreciated that the rise of oxygen *ca*. 2.3 billion years ago owes it's sources of dioxygen to this metabolism, there is a substantial and longstanding debate about its evolutionary timing, with estimates ranging across more than one-and-a-half billion years of early Precambrian time.

Since the inception of Precambrian paleontology, photosynthetic Cyanobacteria (then blue-green algae) were considered among the earliest cells to appear in Earth surface environments. Here we present a suite of complementary observations for the origin and evolution of oxygenic photosynthesis from both the geological record [redox proxy data and models] and the biological record [structural biology of the reaction centers, and new constraints from the recent discoveries in the Cyanobacteria phylum of two clades of nonphotosynthetic close sister taxa to the photosynthetic Cyanobacteria (*Oxyphotobacteria*): the *Melainabacteria* and *Sericytochromatia*] that illustrate why this early adopted, and commonly held, premise is likely incorrect.

Data from both geological and biological archives illustrate that this metabolism, despite its biogeochemical prominence, is a relatively late discovery in the context of Earth's history. This suggests that stem-group *Oxyphotobacteria* arose close in time to the rise of oxygen, and demands that we take seriously the possibility that the rise of oxygen *ca*. 2.3 billion years ago was more or less directly caused by the evolution of oxygenic photosynthesis.