**Supplementary electronic materials S2:**

**Sources of endogenous oxidative stress in photosynthetic eukaryotes**

Interestingly, the plastids could have been the first endosymbionts, which, in contrast with the earlier mitochondrial scenario, were due to incomplete non-digestive phagocytosis of cyanobacteria. Their later uptake gave rise to autotrophic eukaryotes. However, just as with mitochondria, not a trace of a “phagocytotic” membrane is left, so this uptake might also have occurred before the emergence of phagocytosis. A recent publication suggests the cyanobacterial lineage diverging from the plastid lineage 2.1 x 109 years ago; while the ancestor of photoautotrophic eukaryotes possibly lived 1.9 x 109 years ago [1]. Thus, photosynthetic eukaryotes could be among the oldest eukaryotic clades. However, basal nodes of the eukaryotic tree are not well resolved and lack statistical support [2, 3]. Complicating matters, some key meiosis genes already duplicated in LECA, have separate histories of duplication/loss in plant and protist lineages as compared to the animal/fungus clade [4].

Regardless of the timing of events, photosynthesis is the major source of oxidative stress in photoautotrophic organisms which do not suffer so much from stress factors of heterotrophic metabolism (intense motility, phagotrophy), but nevertheless do have meiotic sex. Modern plant cells have 30-100 times higher H2O2 levels than animal cells [5]. In photosynthetic (or mixotrophic) eukaryotes, exposure to high light intensities or prolonged photoperiods as well as deceleration of the Calvin cycle when CO2 is limited, create transferable electrons in abundancies conductive to ROS production [6]. Basically, if more electrons are available than receptor molecules other than oxygen, ROS as superoxide anion radical and H2O2 can arise. Higher relaxation of photosynthetic pigments due to high light amounts results in reactive singlet oxygen which is reduced more easily to superoxide anion radicals than triplet oxygen [7, 8]. Mirroring alpha-proteobacteria (in the form of mitochondria), endosymbiontic cyanobacteria (in the form of plastids), now produce this inside eukaryotic cells, instead of releasing it into the surroundings. Photorespiration acts as a further internal ROS source, in the form of H2O2. This is a light-induced, temperature-sensitive process, in which Rubisco uses oxygen instead of CO2 as electron acceptor, depending on their relative concentrations. The resulting 2-phosphoglycolate can be metabolized in peroxisomes via a sequence of energy-consuming reactions, during which H2O2 is released. Photorespiration is a disadvantageous side-process of photosynthesis as it reduces both net carbon fixation and growth [9]. Photosynthesis and CO2 fixation via Rubisco evolved in the early earth’s atmosphere, in which oxygen concentrations were too low to compete with CO2, and oxygen produced by cyanobacteria was released in the surrounding water. But, as endosymbionts, chloroplasts release oxygen inside the cell, raising relative concentrations of oxygen versus CO2. With the increase of intracellular oxygen concentrations, photorespiration became a significant ROS producing and energy-consuming competitive pathway in plant metabolism; only some of the most recent lineages of flowering plants are able to reduce photorespiration efficiently via C4 photosynthesis [9]. Thus, also photorespiration exemplifies the oxygen paradox of life: oxygen allows very efficient energy (ATP) generation, but has severely detrimental effects because it leads to ROS induced molecular damage [10, 11]. In the dark, most oxygen radicals in plants are produced by mitochondria (as in heterotrophic organisms) [12]. In both mitochondria and plastids, separate genomes were retained, possibly because the genes encode proteins which allow direct responses to changes in redox states under different environmental conditions [13].

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