Tracking the ecological expansion of eukaryotes in Proterozoic oceans using kerogen-bound lipid biomarkers

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The divergence and ecological expansion of marine eukaryotes throughout the Proterozoic Eon (2500 – 542 Mya) can be constrained with complementary microfossil and molecular fossil (lipid biomarker) records garnered from sedimentary rocks that have undergone a mild thermal history. Lipid biomarker assemblages suggest that primary productivity in the Mesoproterozoic and early Neoproterozoic ocean was dominated by communities rich in bacteria as revealed by a dearth of syngenetic sterane (eukaryotic) biomarkers. Reliable evidence for the earliest diverse series of sterane biomarkers produced by eukaryotes are found in pre-Sturtian (older than 720 Ma) rocks; here from the Chuar Gp., Grand Canyon (780-742 Ma) and the Visingsö Gp., Sweden (~800-700 Ma). Comparing the *free* and *bound* biomarker pools from the solvent extract and kerogen phases [1], respectively, reveals that eukaryotic primary producers were becoming ecologically prominent prior to the Sturtian glaciation event. A fundamental shift in the taxonomic affinity of the dominant marine eukaryotic phytoplankton, from red to green algal lineages, occurs through the Neoproterozoic glaciations and likely signifies major changes in marine chemistry and the balance of nutrients.

Additionally, two unusual sterane series are reported; including a C_{28} sterane series (tentatively identified as 26-methylcholestane, 26-mec) from both locations and a C_{30} sterane series (unknown sterane compound) found only in the most thermally well-preserved Chuar samples. It has been postulated that the 26-mec series may have been produced by early animals (sponges) or heterotrophic protists; since sponges have the ability to methylate the sterol side chain at positions other than C-24 [2], although 26-mec is only known to be present as trace sterols from modern sponges. 24-isopropylcholestane, used as a lipid biomarker for tracking the earliest demosponges [1], have not yet been detected in any pre-Sturtian-age rocks.

[1] Love *et al.* (2009) *Nature* **457**, 718-722.
[2] Brocks *et al.* (2015) *Geobio.* **14(2)**, 129-149.