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Synglacial biomarkers from Snowball Earth offer new insights on early eukaryote evolution

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Conventional investigations of biomarkers denoting Eukarya typically explore sterane and steroid distributions in bitumen and kerogen phases of organic-rich marine sediments. However, the biosynthetic pathway of the conversion of squalene to recognisable cholesterol, ergosterol and stigmasterol involves several intermediate phases, the so-called "protosterols", which are rarely detected in molecular fossil studies. Here we present the discovery of steranes and protosteroids from shales intercalated between Snowball Earth glacial diamictites. We find that protosteroids comprise a large fraction of all steroid distributions. These protosteroids either point to notable activity of stem group eukaryotes during the Snowball Earth events, or unusually abundant protosterol-producing bacteria. The extremely low abundances of conventional trifecta steranes relative to bacterial hopanes, and a notable absence of C_{29} stigmastane, disrupts the current view that green (chlorophyte) algae became prominent in the Cryogenian [1,2]. Based on our new results, chlorophyte algae may thus not have risen in the warm period between the two Neoproterozoic Snowball Earth events, but likely only became prominent in the aftermath of the last Snowball. The emergence of chlorophytes as dominant primary producers in the early Ediacaran, and thus the major source of energy, carbon and nutrients flowing through marine ecosystems, likely played a deciding role in the major biotic innovations that unfolded in the terminal Proterozoic.

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