Diagenetic origin of Neoproterozoic 'sponge biomarkers'

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Establishing when animals emerged and when they first gained ecological importance remains one of the great challenges in geobiology. C_{30} sterane biomarkers that are ubiquitous in Ediacaran sedimentary rocks were proposed to be diagnostic for demosponges, and it was suggested that demosponges emerged as the first ecologically important animals on Earth by the end of the Cryogenian period (before 635 Ma) [1,2].

However, assigning Neoproterozoic C_{30} steranes to demosponge sources is problematic for several reasons [3–5]. Most importantly, C_{30} steranes are often found in sediments of anoxic basins [6,7], conditions unlikely to be tolerated by benthic sponges. Therefore, alternative origins of these molecules should be explored.

The existence of 2- and 3-methyl steranes with no known direct biogenic precursors in oils and bitumens has been explained *via* the diagenetic methylation of conventional sterols [8]. Using laboratory pyrolysis experiments to simulate the geological fate of sterols, we show that various unconventional 'sponge biomarkers' can also be readily formed through diagenetic methylation of common C_{29} sterols, and therefore could be derived from algal sources in Late Neoproterozoic sedimentary sequences. Thus, Ediacara biota fossils provide the oldest known evidence for animals [9], whereas the exact timing and environmental context of the first emergence of animals still remain to be uncovered.

[1] Love *et al.* (2009) *Nature* **457**, 718-721. [2] Zumberge *et al.* (2018) *Nature E&E* **2**, 1709. [3] Nettersheim *et al.* (2019) *Nature E&E* **3**, 577. [4] Botting, Muir (2018) *Palaeoworld* **27**, 1-29. [5] Antcliffe (2013) *Palaeontology* **56**, 917-925. [6] Stolper *et al.* (2017) *Geobiology* **15**, 401-426. [7] Bhattacharya, Dutta (2015) *Precambrian Res.* **266**, 361-374. [8] Summons, Capon (1991) *GCA* **55**, 2391-2395. [9] Bobrovskiy et al. (2018) *Science* **361**, 1246-1249.