

Planktic Foraminifera Diurnal Physiology Influences Mg/Ca Ratio Incorporation

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Ratio Incorporation

The Mg/Ca ratio in the tests of planktic foraminifera correlates with temperature, and provides a useful paleoceanographic temperature proxy. However, ‘vital effects’ during foraminiferal calcification processes exert a major influence on Mg incorporation, both decreasing its concentration and increasing its sensitivity to temperature compared to inorganic calcite. The impact of these biomineralisation processes is evident in intra-test strong Mg/Ca banding found in the tests of many foraminifera, with higher-Mg calcite produced at night and lower-Mg during the day [1, 2] This led to the hypothesis that these banding patterns are caused by diurnal changes in photosynthesis and respiration rates driving substantial changes in the chemistry of the boundary layer surrounding the organism during calcification. This hypothesis is supported by microsensor measurements of oxygen and pH of evolved boundary layers, which showed strong light-triggered changes in microenvironment chemistry. [3,4] However, experiments to date identified that the transition between photosynthesis- and respiration-dominated microenvironments is fast relative to the speed of calcification, but the transition between Mg/Ca bands in most foraminiferal tests are gradual, rather than sharp. This is at odds with light availability being a primary driver of Mg/Ca banding.

To examine this relationship, we measured photosynthesis and respiration in individual *Orbulina universa* specimens. We observe strong and systematic variations in photosynthetic rate over a 12 hour period under constant high irradiance period. Notably, net photosynthesis rates did not correlate directly with light availability, but increased gradually after the lights were turned on, and started to decrease before the lights were turned off . This implies a strong role for the modulation of microenvironment chemistry by the circadian rhythm within the photosynthesis of dinoflagellate symbionts, as well as light availability.

1.Spero, H.J et al. *Earth and Planetary Science Letters*, 409, pp.32-42

2. Fehrenbacher et al. 2017. *Nat Comm*. 8(1), p.15441.

3.Rink et al. (1998). *Marine Biology*. 131, pp.583-595.

4.Köhler-Rink & Kühl, M. (2005) *Marine Biology Research*.