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The effect of carbonate chemistry and light levels on calcification and photosynthesis in the larger benthic foraminifera *Operculina ammonoides*

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We present data on metabolic measurements and growth experiments conducted on *Operculina ammonoides*, a symbiont bearing larger benthic foraminifera (LBF) of the family Nummulitidae, which is the closest living descendant of the Eocene Nummulites. The large size, the high abundance and wide distribution of Nummulitids and other LBF make them a vital archive for ancient and recent oceanic environments. LBF are also an important component of the ocean tropical and subtropical benthic ecosystem, where they have a significant contribution to primary production, and are major calcium carbonate producers. Their symbiosis, calcification physiology, and ecological response to environmental changes are poorly understood. The present study is part of an ongoing research effort focused on those topics.
Calcification, respiration and symbiont photosynthesis were measured during long-term experiments that included manipulation of carbonate chemistry parameters and light levels. The experiments were done with large number of individuals (1500 in total) divided into incubation groups of 60-100.
Diurnal and nocturnal data was obtained, along with cumulative incubations on a time span of a few days. The metabolic rates were estimated from measurements of dissolved oxygen, total alkalinity and pH before and after the incubations. This technique does not interfere with the experimental populations and allow a series of measurements to be performed on the same specimens.

In all experiments, both for the diurnal cycles and for the long incubations, we observed significantly higher photosynthesis rates than respiration (positive O_2 budget) for the holobiont. This oxygen excess has increased with light intensity, suggesting a significant growth of the symbionts within their host. Calcification was enhanced during the day compared to the night but did not increase with light intensity or with photosynthesis. In normal seawater, higher calcification rates were observed during the cumulative incubations despite lower alkalinity and pH values that developed in the closed systems. However, in the carbonate chemistry incubations, calcification rates increased linearly with carbonate ion concentration and initial pH levels. Photosynthesis did not show any trend with pH, calling into question the direct coupling between photosynthesis and calcification.

These data suggest that symbiosis and calcification in *O. ammonoides* is quite different from what is known for hermatypic corals but similar to Amphistiginiids that were studied previously. Internal carbon cycling and the dependence on light intensity may affect both the structure of foraminiferal shells and their isotopic and chemical composition, which serves for paleoceanographic reconstructions.