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The complexity of circadian clocks in symbiotic corals

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Circadian regulation of plant-animal endosymbioses is complicated by a diversity of internal and external cues. Reef-building corals exhibit complex rhythmic biological behaviors. Understanding circadian regulation in these organisms is complicated by their photosynthetic endosymbionts (*Symbiodinium* spp.). Photosynthesis by the symbionts results in coral tissue being hyperoxic by day but near hypoxic by night when respiration dominates. To better understand how corals tune their circadian machinery to respond to external and internal cues, we performed microarray analysis of coral genes. We show that stress-related genes in corals are coupled to the circadian clock, anticipating major changes in the intracellular milieu. In this regard, numerous chaperones are "hard-wired" to the clock, effectively preparing the coral for the consequences of oxidative protein damage imposed by symbiont photosynthesis, including synexpression of antioxidant genes being light-gated. Conversely, central metabolism appears to be regulated by the hypoxia-inducible factor system in coral. These results reveal the complexity of endosymbiosis as well as the plasticity regulation downstream of the circadian clock.

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