Diel Variation in Coral and Algal Respiration and Photosynthesis

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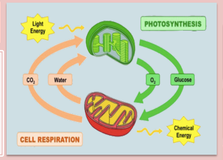
Introduction

Coral and algae work and rest
Throughout the day
I'd like to know when



Importance

- Respiration is often used as a measure of coral health in physiological studies
- Respiration and photosynthesis are the primary pathways for carbon to cycle through coral reef ecosystems
- Understanding these processes is an integral factor in a holistic understanding of reef ecosystems

What Do We Know?

- Respiration is higher after exposure to light than darkness aka Light-enhanced dark respiration (LEDR)
- Respiration increases with photosynthesis due to the oxidation of malate, a product of photosynthesis
- The Kok Effect is a period of respiratory depression just after sunrise that exists in terrestrial plants
- Most studies assume the nighttime respiration rate is constant, which is an accepted underestimation

Knowledge Gaps

- How does LEDR manifest over a 24 hour day?
- Does increased respiration lag behind increased photosynthesis?
- Does the Kok effect exist in coral and benthic algae?
- To what extent do we underestimate the variability in respiration?

Research Questions

1. What is the respiratory scheduling of coral and benthic algae?
2. Do coral and benthic algae provide examples of the Kok Effect (depressed respiratory rate after sunrise even as photosynthesis increases)?
3. What is the relationship between respiration and PAR in coral and benthic algae?

Methodology

Coral and algae were collected from the Hogbreaker reef on Bermuda's North shore at 10m depth

- Five *Porites astreoides*, five *Montastrea cavernosa, and* four *Pseudodiploria strigosa*
- Rocks dominated by *Ceramium nitens, Laurencia obtusa,* or crustose coralline alga were also collected

Experimental Design

- Five aquaria were placed in a common tub with constant flowthrough water
- The tub was covered for 15 minutes every two hours from 9:30-17:30
- One aquarium was left empty to measure background changes

- Each aquarium had a water circulator and O_2, light, and temperature sensors
- One coral or tray of algae was incubated in a sealed aquarium from 06:45 - 20:00
- After every dark period, the water in each aquarium was flushed, and the aquaria were sealed

Data Analysis

- The slope of O_2 change was measured over 15-minute periods and adjusted for coral or algal surface area
- All figures were made using Origin

Results (Research Question 1)

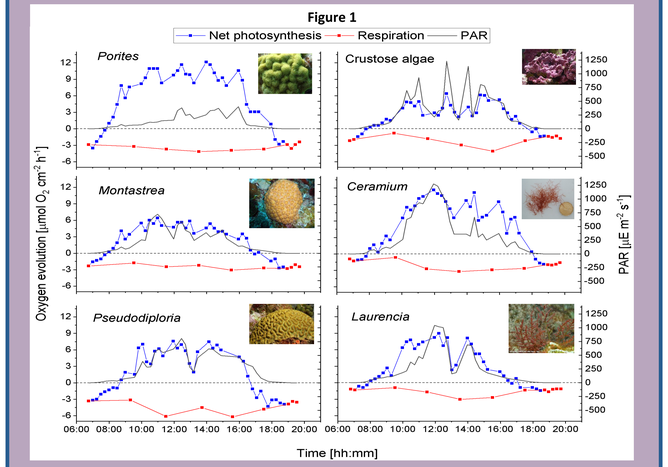


Figure 1

- The changes in oxygen evolution measured by 2-D surface area (right axis) from before sunrise to after sunset as it relates to PAR (left axis).
- Negative oxygen evolution values represent periods of net respiration.
- PAR reaches 0 every two hours as a result of the covering regime.

Results (Research Question 2)

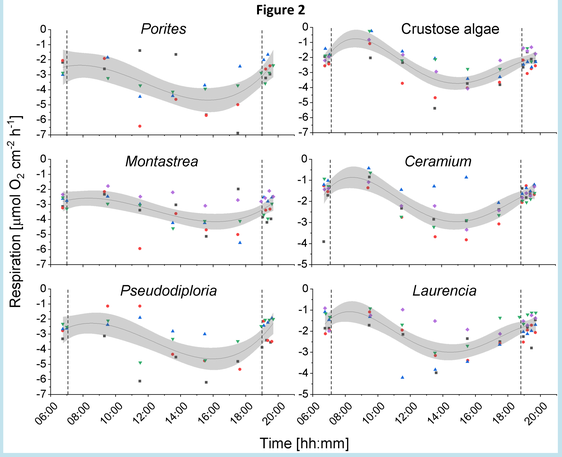


Figure 2

- Changes in respiration vs. time. Negative values show high respiration.
- Respiration is lowest after sunrise and highest around 16:00.
- Shaded region represents 95% confidence interval.

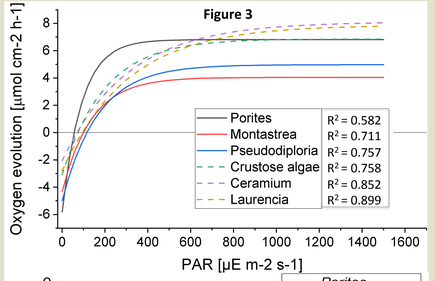
Results (Research Question 3)

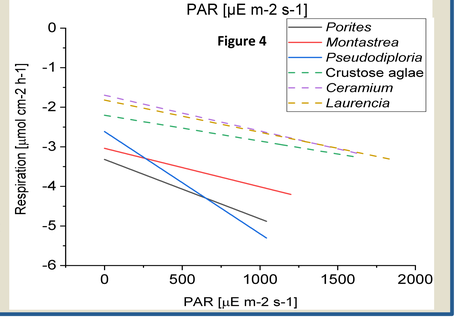
Figure 3
Oxygen evolution (left axis) measured by 2-D surface area as it relates to changes in PAR (bottom axis).

Negative values represent net respiration. Positive values represent net photosynthesis

Figure 4
Respiration (left axis) measured by 2-D surface area as it relates to changes in PAR (bottom axis)

All lines except Crustose algae are significantly different (P<.05) from a slope of zero.





Discussion

Research Question 1

Respiration is generally higher when photosynthesis is higher
However, there seems to be a lag time before respiration increases

Research Question 2

- The Kok Effect seems present in all taxa (especially algae)
- Further statistical analyses may provide more substantive support for this claim

Research Question 3

- Respiration increases significantly as PAR increases
- This relationship is characterized differently in coral than algae

References and Acknowledgements

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