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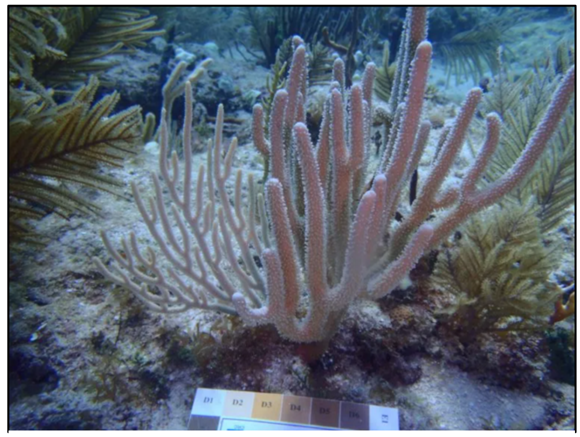
DATA Nugget

Too hot to help? Friendship in a changing climate

Featured scientists: Casey terHorst (he/him) and Richard Rachman (he/him) from California State University Northridge

Research Background:



This coral has lost its algae partners, causing it to be bleached. (Photo by Coffroth Lab)

When given emergency instructions on a flight, you're told to put on your own oxygen mask before assisting others. This is because if you run out of oxygen, you won't be able to help others. Turning to nature, this same idea may be true when we look at relationships between two species.

Coral and certain types of algae form a **mutualism** where both species benefit from the partnership. Coral provides a safe home for algae, and algae make food for coral through photosynthesis. However, climate change is causing warmer ocean temperatures that stress the relationship. If the water gets too hot for algae, they can't make food for the coral anymore. To survive, the algae must help themselves before they can help the coral.

Casey is a biologist interested in studying the changing coral-algae mutualism. He wants to know whether different individuals of the same algae species do better than others in warming waters. Individuals of the same species can have different traits. For example, each human person belongs to the same species, but each of us has different traits. This is largely because of our genetic composition for these traits, or **genotypes**. Casey set out to test if different algae genotypes were capable of being better mutualists under warm temperatures. If he could identify these genotypes, then maybe that could help protect coral in the future.

Casey and his graduate student, Richard, set up experiments to test algae genotypes to see how well they performed at different temperatures. Casey and Richard grew five different genotypes of the same algae species in the lab. They used a pipette to transfer 10,000 cells of each genotype and placed them in flasks at two different temperatures. The lower temperature treatment is one where corals and their algae are usually happy: 26 degrees Celsius. The higher temperature treatment is where coral's relationship with algae starts to break down: 30 degrees Celsius. At that temperature, many corals lose their algae entirely, in a process called coral bleaching.

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Casey and Richard measured two things – the total amount of photosynthesis and the total amount of respiration happening in each flask. They did this by tracking what happened to oxygen over time. When there is a lot of photosynthesis, oxygen goes up, and when there is a lot of respiration, oxygen goes down. Two conditions are best for the mutualism. First, a lot of photosynthesis means the algae produced more food that they can share with coral. Second, less respiration means the algae used less of the food for themselves and have more to share with the coral. In summary, when the algae is stressed it does less photosynthesis and more respiration, making it a worse trading partner for coral. The best algae partner is the genotype that can photosynthesize the most and respire the least. The net food available is how much of the food made through photosynthesis is available after subtracting the food used by respiration.

Casey gets a sample of algae from a flask in his lab. (Photo by David J. Hawkins)

Scientific Question: How do different algae genotypes respond to higher temperatures?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

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Scientific Data:

Use the data below to answer the scientific question:

		Photosynthesis		Respiration		Net Food Available	
Temperature (Celcius)	Algae genotype	Mean	SE	Mean	SE	Mean	SE
26	1	4.83	0.84	-3.83	0.20	1.00	0.75
30	1	3.50	0.84	-0.45	0.20		0.87
26	2	9.71	0.84	-2.48	0.20		0.95
30	2	8.38	0.84	-1.62	0.20		0.70
26	3	5.51	0.84	-4.14	0.20		0.17
30	3	3.15	0.94	-0.70	0.22		0.68
26	4	6.21	0.84	-3.15	0.20		0.42
30	4	6.71	0.84	-1.84	0.20		0.42
26	5	8.64	0.84	-1.97	0.20		0.25
30	5	9.92	0.84	-2.42	0.20		0.82

Note: Photosynthesis releases oxygen into the water, so the values are positive. On the other hand, the values for respiration are negative because oxygen is being used, so it is removed from the water.

You can calculate the ***net food available*** *to coral from the algae by adding the photosynthesis to the respiration. For example, in the first row the net food available is 4.83 + (-3.83) = 1.*

What data will you graph to answer the question?

Independent variable(s): ____

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Dependent variable(s): ____

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Draw your graph below: Identify any changes, trends, or differences you see in your graphs. Draw arrows pointing out what you see and write one sentence describing what you see next to each arrow.

Interpret the data:

Make a claim that answers the scientific question, how do different algae genotypes respond to higher temperatures?

What evidence was used to write your claim? Reference specific parts of the table or graphs.

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Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about the mutualism between coral and algae.

Did the data support Casey's hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Apply this research: Would any of these coral species make better partners for coral in warmer water?

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Casey's research? How do your questions build on the research that has already been done?