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DATA Nugget

Do urchins flip out in hot water?

Featured scientists: Erin de Leon Sanchez (she/her) from University of California - Santa Barbara, Emily Chittick (she/her), and Traci Kennedy (she/her) from Milwaukee Public Schools.

Research Background:

Imagine you are a sea urchin. You're a marine animal that attaches to hard surfaces for stability. You are covered in spikes to protect you from predators. You eat giant kelp - a type of seaweed. You prefer **temperate** water, typically between 5 to 16°C. But you've noticed that some days the ocean around you feels too hot.

These periods of unusual warming in the ocean are called **marine heatwaves**. During marine heatwaves, water gets 2-3 degrees hotter than normal. That might not sound like much, but for an urchin, it is a lot. The ocean's temperature is normally very consistent, so urchins are used to a small range of temperatures. Urchins are **ectotherms.** This means they can't control their own body temperature and rely on the water around them. Whatever the temperature the ocean water is, they are too!

Erin getting ready to scuba dive to look for urchins.

Erin is a scientist who studies how environmental changes, like temperature, affect organisms. Erin first got excited about urchins when she interned with a research lab. When she started graduate school, she learned more about their biology and started to ask questions about how urchins would react to marine heatwaves. Hot water can speed up animals' metabolisms, making them move and eat more. However, warmer temperatures can also cause stress, potentially causing urchins to be clumsier and confused.

One summer, two science teachers, Emily and Traci, came to California to work in the same lab as Erin. Emily and Traci wanted to do science research so they can share their experience with their students. As a team, they decided to test whether marine heat waves could be stressing urchins by looking at a simple behavior that they could easily measure. Healthy urchins have a **righting** instinct to flip over to orient themselves "the right way" using their sticky tube feet.

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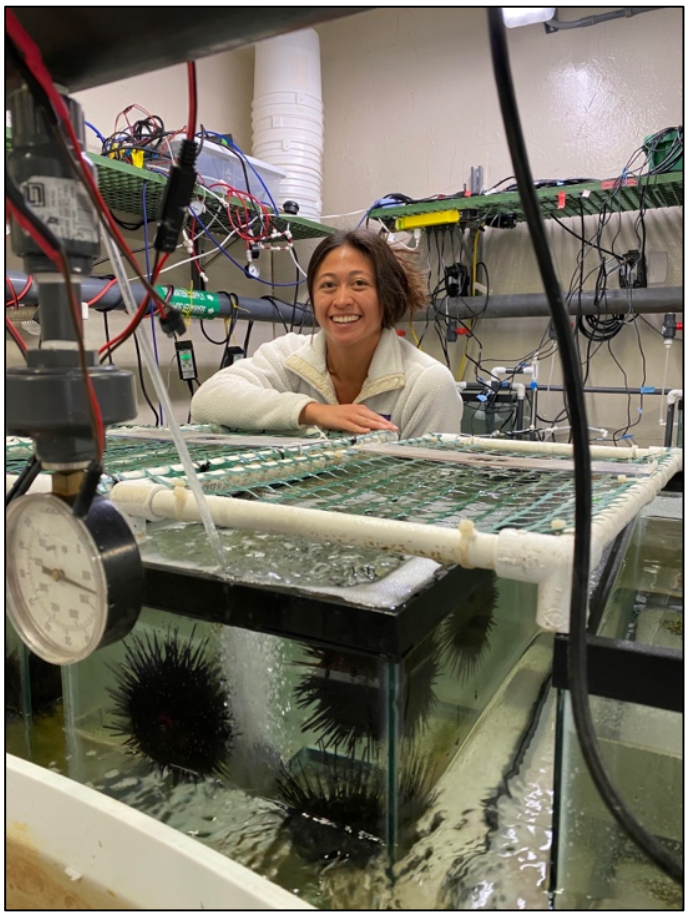
The research team predicted that urchins would be slower to right themselves in warmer temperatures. However, they also thought the response could depend on the temperature the urchins were used to living in. If the urchins had been **acclimated** to higher temperatures, they might not be as strongly affected by the heatwaves.

Together, Erin, Emily, and Traci took 20 urchins into her lab and split them into 2 groups. Ten were kept at 15°C, the ocean's normal temperature in summer. The other ten were kept at 18°C, a marine heatwave temperature. They let the urchins acclimate to these temperatures for 2 weeks. They tested how long it took each urchin to right itself after being flipped over. They did this at three temperatures for each urchin: 15°C (normal ocean), 18°C (heatwave), and 21°C (extreme heatwave). They worked together to test the urchins three times at each temperature to get three replicates. Then they calculated the average of each urchin's responses.



Erin in the urchin lab at her university.

Scientific Question: How does acclimatization to warmer temperatures affect urchin responses to marine heatwaves?

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:

Acclimatization Group	Urchin Number	*Normal Ocean*	*Marine Heatwave*	*Extreme Marine Heatwave*
Normal Ocean Temperature (15°C)	1	97.3	107.7	174.7
	2	82.0	75.0	127.0
	3	113.7	135.7	97.0
	4	73.7	75.3	
	5	93.0	57.0	103.3
	6	127.3	111.7	154.3
	7	98.3	99.3	305.0
	8	107.7	84.0	112.7
	9	90.0	110.3	76.3
	10	116.3	98.0	215.3
Marine Heatwave Temperature (18°C)	11	70.3	64.0	133.7
	12	57.0	52.3	98.0
	13	65.7	48.0	129.3
	14	50.0	114.0	130.7
	15	71.0	56.7	238.3
	16	57.0	87.3	91.7
	17	116.0	102.7	168.7
	18	64.7	45.3	137.3
	19	71.0	76.7	162.3
	20	102.7	129.0	86.7

		Average righting time (seconds)		
		15°C	**18°C**	**21°C**
		Normal Ocean	***Marine Heatwave***	***Extreme Marine Heatwave***
Normal Ocean Temperature	Average			
	Standard Error	5.5	5.5	19.3
Marine Heatwave Temperature	Average			
	Standard Error	4.2	6.2	13.8

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**Standard error (SE) tells us how confident we are in our estimate of the mean and depends on the number of replicates in an experiment and the amount of variation in the data. When there is lower replication and higher variation, SE bars are large. A large SE means we are not very confident, while a small SE means we are more confident.*

***Note: There is a missing data point for Urchin 4 in the first table. The container it was held in was misplaced. The scientists recorded observations for all the other urchins on the same day, so when they found the container with Urchin 4, it was too late to collect data!*

What data will you graph to answer the question?

Independent variable(s): _____

_____

Dependent variable(s): _____

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

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Interpret the data:

Make a claim that answers the scientific question, how does acclimatization to warmer temperatures affect urchin responses to marine heatwaves?

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

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how urchins respond to the temperature of their environment.

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

Apply this research: Sea urchins have spikes for defense so that predators don't want to eat them. There are fewer spines on their undersides. These spines are also shorter. Some predators will flip urchins over to eat them. Based on the data from Erin's experiment, what do you predict will happen if there are more heatwaves? Would hot water cause urchins to be more or less vulnerable to predation? Explain your answer.

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