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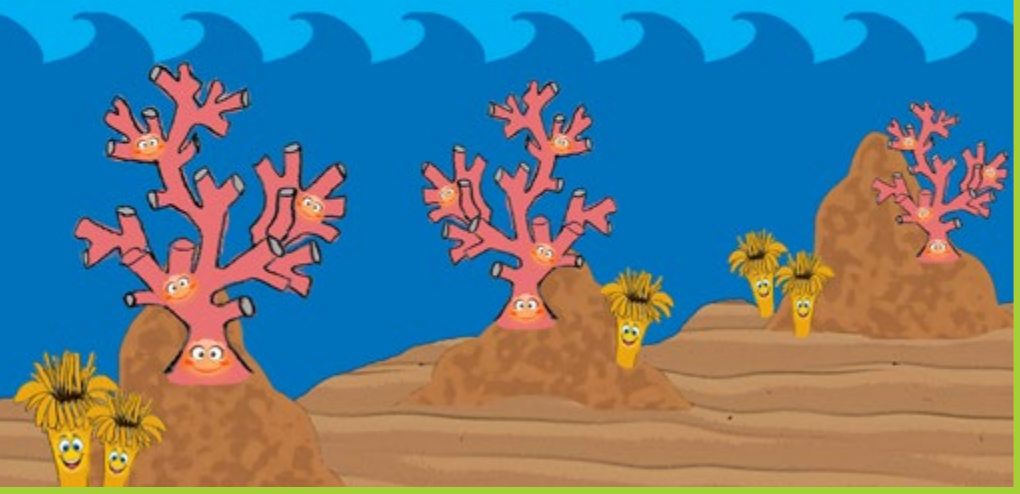
How do corals spread in the deep sea?



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Abstract

Did you know that more people have been on the moon than to the very bottom of the sea? Science is hard to do at such depths, which is a problem for deep sea animals – it's hard to look after something if you don't know much about it!

We wanted to know how *seamounts* (underwater mountains) affect the populations of two species of deep sea coral. Can they act as "stepping stones" helping the corals to *disperse* (spread) throughout the sea?

We used clever genetic analysis to unlock information hidden in the corals' DNA and found that this was true for one species, but not for the other. We believe that ocean currents are also important in how corals disperse. This new information can help us to protect these important animals (and others!) in the future.

Introduction

Even though such a small number of people have been to the bottom of the sea, we humans can still cause damage to life in the depths. That includes damage from fishing and all our activities that contribute to climate change.

We wanted to find out about two species of deep sea coral, *Desmophyllum dianthus and Solenosmilia variabilis* (meet Diane and Sven in Fig. 1). These corals are important *ecosystem engineers*, so it's essential for us to understand and protect them.

DNA can be a useful tool to study deep sea animals. Not every individual is the same – just think about us! We all look different from each other, and this is because we all have lots of little changes in our DNA. The same goes for corals! This is called *genetic variation*.

If a population has lots of genetic variation, it has *genetic diversity* – and having diverse populations is really important in helping a species adapt and survive in the future.

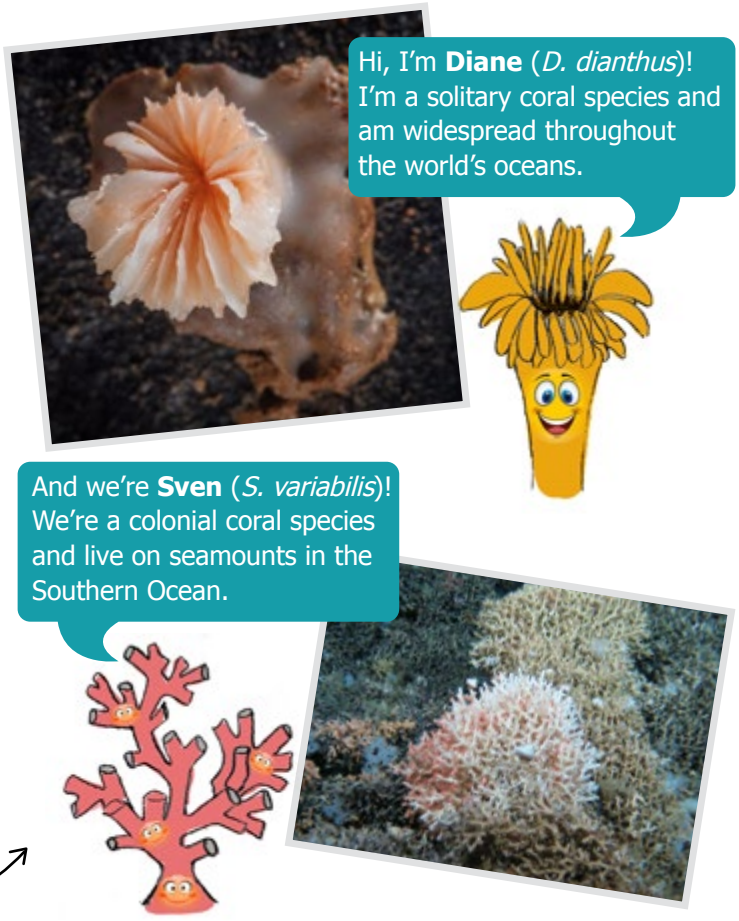


Figure 1:
The two deep-sea coral species we studied: *D. dianthus* (Photo credit: Art Howard, Deepwater Canyons 2012 Expedition, NOAA-OER/BOEM) and *S. variabilis* (Photo credit: AD Rogers, NERC/IUCN Seamounts Project).

When corals reproduce, the *larvae* disperse throughout the sea before settling and growing in a new place – like seeds from a dandelion floating through the air. This is known as gene flow and is how genetic variation spreads throughout the oceans, forming diverse populations. We think that seamounts may assist gene flow by providing "stepping stones" for larval dispersal across the vast ocean.

We wanted to use DNA to find out:

- How much genetic diversity is there in each coral population?
- Do seamounts assist dispersal?

Methods

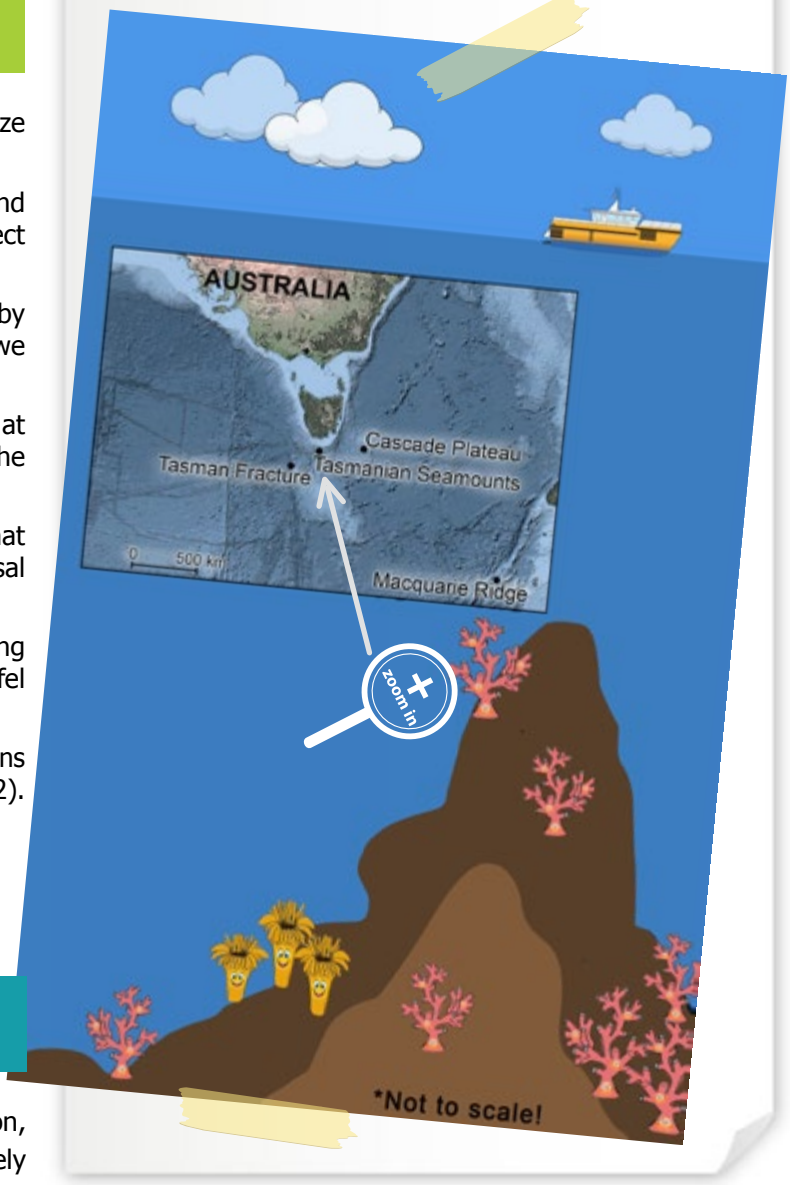
To answer these questions, we had to collect and analyze DNA from the two deep sea corals.

1. Firstly, we went out to sea on a research vessel and used a special machine (called a benthic sled) to collect lots of coral samples from both species.
2. We then preserved our samples (in 95% alcohol or by ultra-freezing) and took them back to the lab, where we extracted the DNA from every single one.
3. We then used fancy software on a computer to look at the genetic variation in each individual and to work out the genetic diversity of each population.
4. Finally, we put all this information on a map so that we could work out how seamounts affected the dispersal of larvae.

We analyzed a total of 951 samples, from depths ranging from 489 to 2395 metres – that's 8x taller than the Eiffel Tower!

We made sure our samples were from a mixture of locations both on seamounts and in other areas of the deep sea (Fig. 2).

Figure 2:
Sampling locations in the Southern Ocean.



Results

For Diane (*D. dianthus*), there was lots of genetic variation, and the populations on different seamounts were closely related to each other (like brothers and sisters). This suggests that when this species reproduces, the larvae can disperse a long way through the sea, settling on different seamounts and resulting in large and diverse populations (Fig. 3). It seems that for Diane, the seamounts assist gene flow by acting as "stepping stones".

Please see Figure 3 on Page 3

For Sven (*S. variabilis*), there was much less genetic variation – in fact, one of our results suggested it was about a quarter of Diane's! The populations on each seamount were not closely related (more like different families). This suggests that when this species reproduces, the larvae stay close to home (within a few hundred meters). Thus, for Sven the seamounts are more like "isolated islands" than closely connected populations.

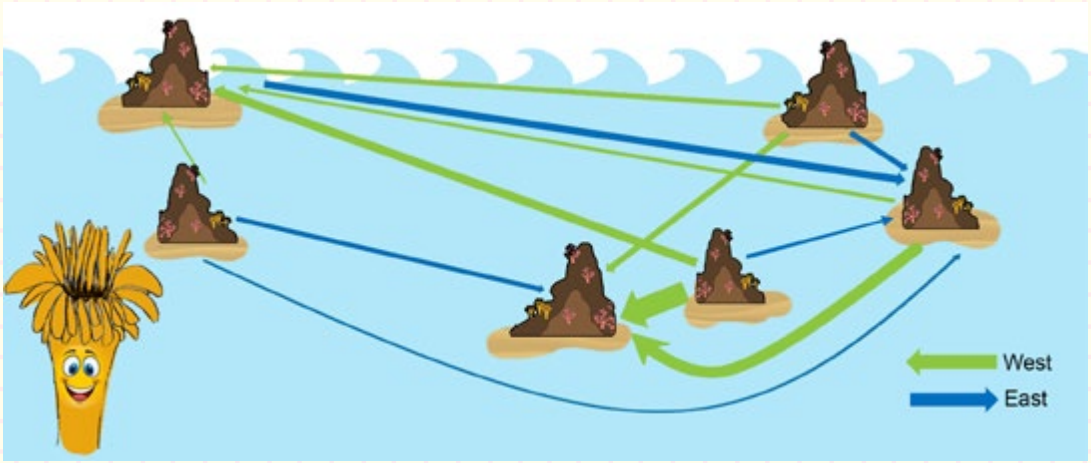


Figure 3:
How genetic variation spreads from seamount to seamount in populations of Diane (*D. dianthus*). The thicker the arrows, the more dispersal of larvae between seamounts. The colors show the direction in which the larvae disperse, which we think is helped by ocean currents.

Discussion

Our results are really important when thinking about how to protect deep sea corals. Coral populations will be best able to survive if they have lots of genetic diversity that is maintained through gene flow (larval dispersal). We have to think carefully about where we put things like Marine Protected Areas to make sure that they protect large (or small) enough areas so that larvae can disperse between populations to keep genetic diversity high. Most of the areas in the Southern Ocean where we studied the two corals are already in marine parks but many other populations of deep sea corals in the world aren't as lucky. Remember – these species are ecosystem engineers, which means that if we can protect them, we'll protect other marine life too!

Conclusion

What we do on land has a big impact on what happens in the ocean – even deep at the bottom. Human activities contributing to climate change are causing a big loss of life and biodiversity in our ocean. The warmer the ocean becomes, the more it affects marine life like corals – but what can you do? Fortunately, there's lots of little actions you can take to help our oceans:

- If you're visiting the sea, take a bag and do a quick beach clean-up.
- Use reusable bags and bottles instead of disposable ones whenever you can.
- Learn more about the oceans and marine life – there's loads of information online. (Check out our references!)

Glossary of Key Terms

Disperse – spread over a wide area.

Ecosystem engineer – any organism that creates, significantly modifies, maintains or destroys a habitat. Corals are ecosystem engineers as they create habitats for other organisms such as fish and crustaceans (like crabs and lobsters).

Genetic variation – the differences in characteristics between individuals of the same species (for example, eye and hair color in humans). Some individual corals are better at living in warmer temperatures, which is a genetic variation that may help them survive climate change.

Genetic diversity – the amount of genetic variation in a species or population of a species.

Larvae – the undeveloped form of an animal before it becomes an adult. This is very common in insects, but corals also produce larvae!

Seamount – an underwater mountain formed by volcanic activity.

Solitary vs colonial – corals can either be solitary (where one animal makes up the whole coral) or colonial (where multiple animals together make up the coral).

Check your understanding

1. Many human activities such as deforestation harm life on land. What can you think of that harms life in the ocean?
2. Seamounts are important in the deep sea. How can they affect the dispersal of coral larvae?
3. What's the difference between genetic variation and genetic diversity?
4. Why are ecosystem engineers such as corals crucial for other marine life? Can you think of any similar examples on land?
5. What can you do to help our oceans?

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