Sponges recycle carbon to give life to coral reefs

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Coral reefs support some of the most diverse ecosystems on the planet, yet they thrive in a marine desert. So how do reefs sustain their thriving populations?

Marine biologist Fleur Van Duyl from the Royal Netherlands Institute for Sea Research is fascinated by the energy budgets that support coral reefs in this impoverished environment.

According to van Duyl's former student, Jasper De Goeij, *Halisarca caerulea* sponges grow in the deep dark cavities beneath reefs, and 90% of their diet is composed of dissolved organic carbon, which is inedible for most other reef residents. But when De Goeij measured the amount of carbon that the brightly coloured sponges consumed he found that they consume half of their own weight each day, yet they never grew.

What were the sponges doing with the carbon? Were the sponges really consuming that much carbon, or was there a problem with De Goeij's measurements? He had to find out where the carbon was going to back up his measurements and publishes his discovery that sponges have one of the fastest cell division rates ever measured, and instead of growing they discard the cells. Essentially, the sponges recycle carbon that would otherwise be lost to the reef. De Goeij publishes his discovery on November 13 2009 in The Journal of Experimental Biology.

Travelling to the Dutch Antilles with his student, Anna De Kluijver, De Goeij started SCUBA diving with the sponges to find out how much

carbon they consume. 'It is quite dark and technically difficult to work in the cavities,' explains De Goeij, but the duo collected sponges, placed them in small chambers and exposed the sponges to 5-bromo-2′-deoxyuridine (BrdU). 'The BrdU is only incorporated into the DNA of dividing cells,' explains De Goeij, so cells that carry the BrdU label must be dividing, or have divided, since the molecule was added to the sponge's water, and cells can only divide if they are taking up carbon. But when De Goeij returned to the Netherlands with his samples, he had problems finding the elusive label.

Discussing the BrdU detection problem with his father, biochemist Anton De Goeij, De Goeij Senior offered to introduce his son to Bert Schutte in Maastricht, who had developed a BrdU detection system for use in cancer therapy. Maybe he could help De Goeij Junior find evidence of cell division in his sponges.

Taking his samples to Jack Cleutjens's Maastricht Pathology laboratory, De Goeij was finally able to detect the BrdU label in his sponge cells. Amazingly, half of the sponge's choanocyte (filtration) cells had divided and the choanocyte's cell division cycle was a phenomenally short 5.4 hours. 'That is quicker than most bacteria divide,' exclaims De Goeij.

The sponge was able to take up the colossal amounts of organic carbon that De Goeij had measured, but where was the carbon going: the sponges weren't growing. De Goeij tested to see if the cells were dying and being lost, but he couldn't find any evidence of cell death.

Presenting his results to the Maastricht Pathology Department, someone said 'Lets look at this like a human intestine, then you should see shedding where old cells detach from the epithelia'. De Goeij knew that he had seen some loose cells, and thought that they were artefacts from cutting the samples, but when he and his Pathology Department colleagues went back and looked at the samples, De Goeij realised that

choanocytes were shedding all over the place. And then De Goeij remembered the tiny piles of brown material he found next to the sponges in the aquarium every morning.

The sponges were shedding the newly divided cells, which other reef residents could now consume. '*Halisarca caerulea* is the great recycler of energy for the reef by turning over energy that nobody else can use [dissolved organic carbon] into energy that everyone can use [discarded choanocytes],' explains De Goeij.

De Goeij, J. M., De Kluijver, A., Van Duyl, F. C., Vacelet, J., Wijffels, R. H., De Goeij, A. F. P. M., Cleutjens, J. P. M. and Schutte, B. (2009). Cell kinetics of the marine sponge Halisarca caerulea reveal rapid cell turnover and shedding. J. Exp. Biol. 212, 3892-3900. jeb.biologists.org

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