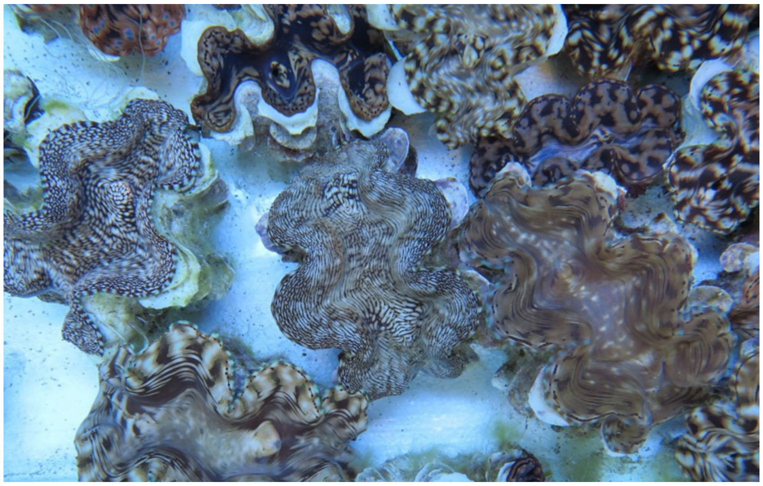
INSIDE JEB

Giant clams make most of urea thanks to lodger algae



Giant clams (*Tridacna squamosa*). Photo credit: Yuen K. Ip.

Some duos are timeless, from the partnerships between Mr Rolls and Mr Royce, Tom and Jerry, and symbiotic alliances in which one partner provides refuge in return for the nutrition produced by its photosynthetic algae lodgers (zooxanthellae). Symbiotic giant clams make the most of the deal struck with their resident algae, 'More than 95% of the photosynthate produced by the zooxanthellae is donated to the host', says Yuen K. Ip from the National University of Singapore. However, the algae cannot provide all of the clam's dietary requirements. They have no access to nitrogen – which is essential for building proteins – from the impoverished tropical waters, depending instead on their clam guardians to provide them with nitrogenous substances (such as ammonia produced by fish) by absorbing it directly from the environment. But Ip wondered whether the clams may also take advantage of a more lucrative source of nitrogen: urea, which is excreted by some creatures. 'Although urea is available at seemingly low concentrations around coral reefs, it represents a significant amount of nitrogen in the seawater', he says. Intrigued by the possibility, Ip and his team investigated whether giant clams simply suck up urea from their surroundings.

Immersing clams in seawater dosed with urea (50 μmol l^{-1}), the team was impressed to see the concentration of urea fall; they were particularly intrigued as the clams absorbed 1.5 times more urea when they were exposed to light than in the dark. But how was the clam able to extract urea from its surroundings when the concentrations were so low? Reasoning that the animal must produce a protein pump in some tissues to absorb urea, the team searched for a possible candidate – a transporter known as DUR3 – and were pleased to find a similar protein produced in the clams' gills. And when they monitored the levels of the pump protein in the gill, it increased 8-fold over a period of 12 h when the lights were on.

Not only can the clams absorb urea from their surroundings but also they do so during daylight, and Ip explains that this makes sense. When each molecule of urea breaks down, it produces ammonia, which the algal residents can convert into amino acids for the clam's use, while carbon dioxide – which is essential for the photosynthetic production of sugars by the algae – is also released. By absorbing dilute urea during daylight, the clams can coordinate photosynthesis, thanks to the released carbon dioxide, and protein production, from the ammonia that is produced, to get two bangs for each urea buck.

10.1242/jeb.181040

Chan, C. Y. L., Hiong, K. C., Boo, M. V., Choo, C. Y. L., Wong, W. P., Chew, S. F. and Ip, Y. K. (2018). Light exposure enhances urea absorption in the fluted giant clam, *Tridacna squamosa*, and up-regulates the protein abundance of a light-dependent urea active transporter, DUR3-like, in its ctenidium. *J. Exp. Biol.* **221**, doi:10.1242/jeb.176313.

Kathryn Knight
kathryn.knight@biologists.com

Inside JEB highlights the key developments in Journal of Experimental Biology. Written by science journalists, each short report gives the inside view of the science in JEB.