Biogenic buffering by sea cucumbers reduces nighttime dissolution on coral reefs

Kennedy Wolfe[1], Francisco Vidal-Ramirez[2], Sophie Dove[2], Maria Byrne[1]

[1] School of Medical and Biological Sciences, The University of Sydney, NSW

[2] School of Biological Sciences, The University of Queensland, QLD

Introduction - On coral reefs, deposit feeding sea cucumbers influence local carbonate chemistry through their digestive physiology and dissolution of calcium carbonate ($CaCO_3$) sediment(1) (Fig 1a). Resulting changes in total alkalinity (A_T) and dissolved inorganic carbon (DIC) could alter the buffer capacity (A_T:DIC) of seawater(2). By influencing the A_T:DIC ratio, biogenic buffering by sea cucumbers may have the potential to partially ameliorate the negative effects of ocean acidification, improving conditions for coral reef calcifiers.

Methodology - Mesocosms (Fig 1b) were set up at Heron Island Research Station (HIRS) reflecting the local lagoon sediment habitat, and were acclimated at present-day and near-future pCO_2 (+570 µatm). Mesocosm conditions fluctuated with the natural temperature/pH levels recorded *in situ* on Heron Reef(3). The influence of *Stichopus herrmanni* on seawater chemistry was determined from discrete water samples taken across day and night incubations (n=5) in mesocosms with and without sea cucumbers.

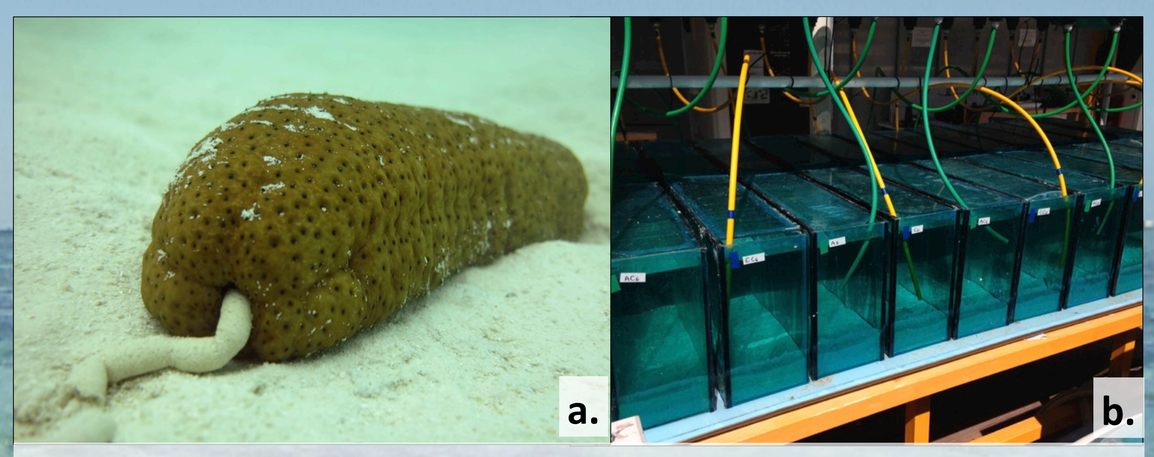

Fig 1: a) *S. herrmanni* bioturbation, b) mesocosm set up at HIRS

Daytime

1) Negative dissolution (**calcification**) occurred (Fig 2a)
2) pH and A_T:DIC **increased** across all mesocosms (Fig 2b).
3) Changes in water chemistry were **greater** in mesocosms **without** sea cucumbers.
4) The presence of *S. herrmanni* had a **drawdown** effect on daytime calcification and A_T:DIC

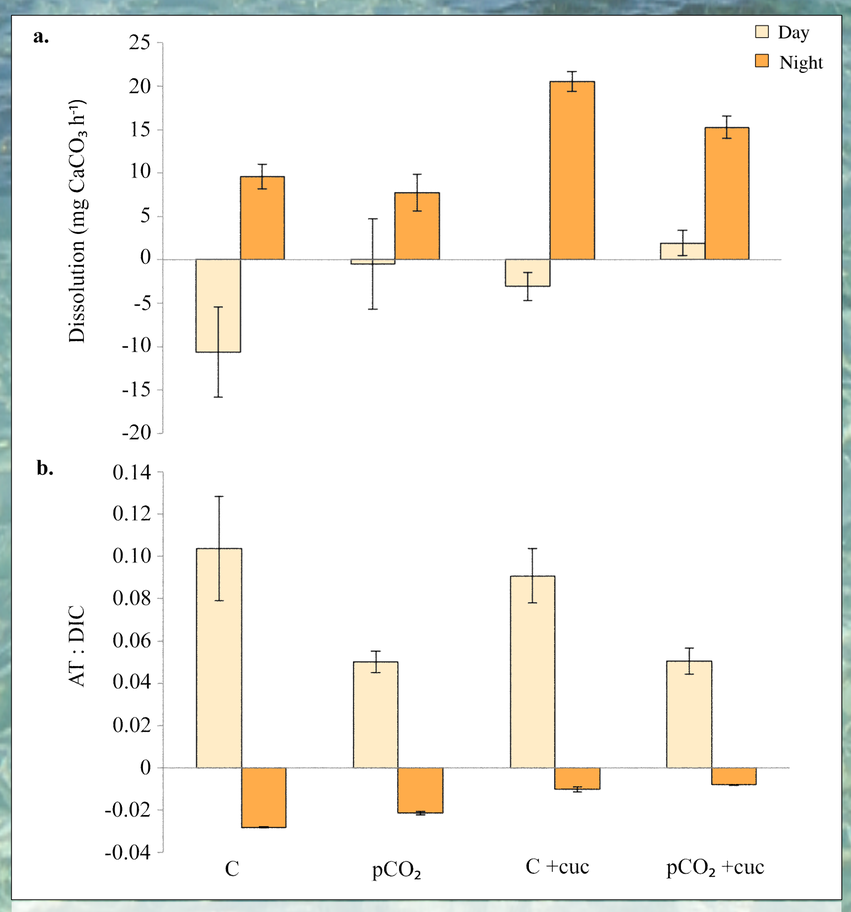

Fig 2: Changes in a) dissolution, and b) buffering capacity across day and night incubations in mesocosms with (+cuc) and without *S. herrmanni.*

Nighttime

1) $CaCO_3$ **Dissolution** was highest at night and elevated pCO_2 (Fig 2a).
2) pH and A_T:DIC **decreased** across all mesocosms (Fig 2b).
3) Changes in water chemistry were **greater** in mesocosms **without** sea cucumbers.
4) Mesocosms with *S. herrmanni* were **20-25% higher** in pH and had a buffer capacity **20-33.3% higher** than mesocosms without sea cucumbers.

Conclusions

- Reductions in net calcification of coral reefs have been largely attributed to increases in nighttime dissolution as opposed to reductions in daytime calcification(4,5).
- Biogenic buffering by *S. herrmanni* (and likely other sea cucumbers) at night may be particularly important in reducing community dissolution, thereby contributing to the maintenance of coral reef structures.
- This may increase in importance as ocean pH decreases over coming decades.
- As a species recently listed as vulnerable to extinction due to commercial overharvest, our findings highlight the potential negative effect of the global béche-de-mer fishery to coral reef chemistry and future reef resilience.

References

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