Coral recruitment at sites with and without cyanobacteria blooms on Midway Atoll, NW Hawaiian Islands

Wendy A. Cover and Donald C. Potts
Ecology Dept., Univ. of California, Santa Cruz. cover@biology.ucsc.edu

Introduction:
Benthic cyanobacteria contain numerous toxic compounds known to negatively impact marine life (e.g. in Moreton Bay, Australia: Pittman and Pittman 2005). The toxic cyanobacterium *Lyngbya majuscula* reduced survival and recruitment of three species of coral larvae (Kuffner and Paul 2004, Kuffner and Walters 2006). On Midway Atoll, potentially harmful benthic cyanobacteria blooms are associated with anthropogenic iron debris in the lagoon. At two sites, periodic blooms of *Hormothamnion enteromorpha*lide, a benthic cyanobacterium, approach densities of 50% cover of rocky surfaces. We tested the hypothesis that benthic cyanobacteria blooms have a negative impact on coral recruitment. Specifically, we expected to find fewer corals on settlement tiles placed within bloom sites than on tiles in nearby control sites.

Methods:
We deployed settlement tiles at 6 sites in the shallow backreef lagoon of Midway Atoll (Northwest Hawaiian Islands). Two sites, Reef Hotel (RH) and Rusty Bucket (RB) have extensive iron debris and experience periodic blooms of cyanobacteria during the spring and summer months. Two control sites, RH Far and Forbidden Beach (FB Patch), are nearby and experience similar oceanographic influences as the bloom sites, but do not have iron and do not experience blooms. The final two sites, Site 163 and the Hook, are far from known human impacts and have not had blooms during observations from 2005 to 2007. At each site, we deployed 10 replicate sets of two sandwiched terra cotta tiles (~14 x 15 cm) spaced ~3 cm apart. We attached the tiles vertically with a stainless steel screws through the center of each pair to raised reef structure close to, but not touching corals. All tiles were in 1-2 m of water.

Tiles were deployed in June 2007 and collected in July 2008, for a total of 13 months in the water. They were cleaned of macroalgae and bleached to remove remaining live tissue. Coral recruits were found by searching under a dissecting scope at 6x - 25x power. All tiles were searched completely at least two times by two different people. All coral recruits were identified, when possible, to family or genus.

Results:
• There were significantly more coral recruits in the cyanobacterial bloom sites than in the adjacent control sites or in the distant control sites (p<0.001 for all treatments; ANOVA, Tukey multiple comparisons, Fig. 1).
• There was no significant difference in numbers of recruits based on tile position (inner vs. outer in the sandwiched pair).
• This pattern of higher recruitment in cyanobacterial bloom sites vs. controls was similar for all of the primary coral taxa: *Pocillopora* (p=0.019), *Porites* (p=0.003), and *Faviidae* (p=0.014; multivariate analysis of variance (MANOVA) with general contrast approach; Fig. 2).

Conclusions:
Results were exactly opposite of the hypothesized outcome: recruitment was higher at sites with cyanobacterial blooms and lower at nearby control sites. Distant control sites were intermediate between the two, but still had lower recruitment than bloom sites.

Possible explanations include:
1) Blooms either do not deter coral larvae, or are infrequent enough to not affect coral recruitment; and the differences between sites are a result of natural local variability in recruitment and/or small-scale oceanographic patterns;
2) Iron or other metals at these sites attract coral recruits.
3) Cyanobacterial blooms somehow promote coral settlement and/or subsequent survival (recruitment), despite containing potentially harmful compounds.

It is also possible that survival of coral recruits, if not overall number of settlers, was reduced by the presence of cyanobacteria. We are now quantifying survival of recruits (i.e. alive or dead at time of collection) in this experiment to answer this question.

Based on these results, removal of iron debris to manage cyanobacterial blooms on Midway may be unnecessary, at least with regard to improving coral recruitment.

Acknowledgements:

Funding: Mitsubishi Corporation (Tokyo) - Global Coral Reef Conservation Project

References:

Figure 1. Differences in recruitment between treatment groups.
P < 0.001 between each treatment.

Figure 2. Differences in recruitment by coral taxa between treatment groups.