Evaluating the Large-scale Impacts of Sediment on Coral Reefs in the Field

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EXTENDED ABSTRACT

Coral reefs are severely degraded in the Caribbean and are showing few signs of recovery, which is due, in part, to chronic stressors such as terrestrial run-off. Increased sedimentation is an important management concern in the Caribbean, where rapid development has been associated with increased erosion and potential impacts on downstream coral reefs. High sedimentation is known to be detrimental to corals in small-scale experiments, yet we still have a limited understanding of effects of sediment on coral at regional scales. We investigated the effects of sediment on coral in the field using two methods: first a global meta-analysis of available literature, then a field study focused on the eastern Caribbean.

We conducted a systematic search of un-manipulated field studies that measured sedimentation levels and coral cover at multiple sites. We used the correlation between coral cover and sedimentation rate across all sites in a given study (Pearson product-moment correlation coefficient, r, subsequently z-transformed to stabilize variance) as a measure of effect size in our analysis. Only 10 studies provided spatially replicated data that could be included in a meta-analysis of the global relationship between sedimentation rate and coral cover. The overall effect size z was small (z = -0.11) and not significantly different from zero, suggesting that any negative effects of sediment on coral are not detected at this scale with common measurements of these two variables. Several scenarios may explain this unexpected result. Shifts in coral community composition may occur with increased sedimentation in the absence of changes in total coral cover. Variation in sediment characteristics (e.g. size and source) may be important in determining the impact of sediment on coral, yet overall sedimentation rate is the most commonly reported measure. Finally, sedimentation rate is typically measured using sediment traps, which have several recognized flaws and may not provide an accurate representation of sediment delivery to a site. There are therefore many sources of error which may obscure the responses of coral communities to sedimentation as measured in the field across geographically distant locations.

The second part of our study explored whether a relationship exists at a regional scale between sediment characteristics and reef composition in the eastern Caribbean. Because of the difficulties in accurately measuring overall sedimentation rate to an area, we instead assessed the source and size composition of sediments collected from the reef surface. We explored the relationships between surface sediment characteristics and cover of major benthic groups as well as cover of individual coral species across 22 sites across 11 islands. The percent cover of live coral, macroalgae and turf algae decreased with increasing terrigenous fraction of surface sediment, while the cover of sponges increased. Significant differences in coral species assemblages were observed between sites receiving sediment with high and low terrigenous fraction. In particular, the cover of corals in the *Montastrea annularis* complex decreased significantly across sites with increasing terrigenous sediment fraction. The proportion of fine-grained sediment and protection status of the reef (i.e., whether a site was in or out of a Marine Protected Area) had no effect on benthic composition.

Our research revealed that coral reef health is influenced by sedimentation at a regional scale in the eastern Caribbean. It is consistent with previous studies which highlight the limitations of sediment traps in assessing sediment impact on coral reefs and suggests that analysis of surface sediment may be a rapid, inexpensive and useful indicator of sediment stress to a reef. Moreover, our results highlight the importance of monitoring changes in coral species assemblages rather than simply overall coral cover.

Relaciones entre la Composición de los Arrecifes y el Tamaño y Origen del Sedimento en el Caribe Oriental

Aunque experimentos de laboratorio y de campo a pequeña escala han mostrado que el sedimento es perjudicial para los corales, aun tenemos muy poco conocimiento sobre los efectos del sedimento a larga escala en los arrecifes de coral en condiciones naturales. Muestreos bentónicos fueron llevados a cavo en 21 localidades en arrecifes de coral en el Caribe oriental para examinar la relación entre la composición del arrecife y el tamaño y origen del sedimento superficial (calcáreo o terrígeno) adyacente al arrecife. Un aumento en sedimento de origen terrígeno fue asociado con una disminución en al area cubierta por corales, macroalgas y césped algal y un aumento en la cobertura de esponjas. Cambios en los niveles de sedimentos de origen terrígeno fueron también asociados con cambios en la composición de especies de coral. El área cubierta por las especies Porites porites, Madracis mirabilis y Agaricia agaricites disminuyo significativamente con un aumento de sedimento de origen terrigeno, mientras el hidrozoo Millepora alcicornis aumento. No encontramos ninguna relación entre la cantidad de sedimento de grano fino y la composición bentónica. Estos resultados sugieren que la medición de la composición de los sedimentos superficiales podría ser una buena alternativa a las trampas de sedimentos para monitorizar los efectos de la sedimentación sobre las comunidades coralinas en esta región.

PALABRAS CLAVES: Coral, sedimento, composición bentónica, Caribe oriental,