Environmental and ecological cofactors of coral growth anomalies (GA) on Hawaiʻi Island

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Objective: To identify environmental and ecological factors that influence the prevalence and severity of coral growth anomalies (GA)

Background

Growth anomaly (GA) affects multiple coral species in Hawaiʻi (Figure 1), yet its epizootiology remains poorly characterized. GAs impede various biological and physiological functions, defining it clearly as a disease (1, 2, 3). Herpes-like viruses (HLVs) or a consortium of viruses has been identified to associate with GAs although unconfirmed as causative agents (4). Also, host density and human population size have been correlated to the prevalence of GAs on corals in the genera *Acropora* and *Porites* (5), reduced water flow has been correlated to the high severity levels of GAs in *Montipora capitata* in Hawaiʻi (3). However, comprehensive examinations of other environmental and ecological parameters that may be cofactors to GA prevalence and severity have been minimal in Hawaiʻi.

This study examined the effects of water quality and coral community structure on growth anomaly prevalence and severity in all coral species at 5 sites around Hawaiʻi Island.

Materials and Methods

- 5 sites on Hawaiʻi Island (Figure 2)
    - Richardson's Beach Park, Waiʻōpae, Kaloko Honokōhau, Kailua and Kahuwai Bay
    - Various levels of groundwater discharge, proximity to urban development, and coral cover
- 6 x 25m belt transects at each site were used to compare:
    - GA Prevalence (defined as number of colonies afflicted by GA/total # colonies) among sites and species
    - GA Severity (surface area afflicted by GA/total colony area) among sites and species
    - Coral community structure (colony size[cm], species density [# colonies/0.25m^2])
- Photographs of afflicted corals were used to calculate severity and colony area using ENVI 4.8
- Water quality samples (n=3 per transect) to analyze temperature, salinity, and concentrations of nitrate+nitrite, ammonium, and dissolved organic nitrogen

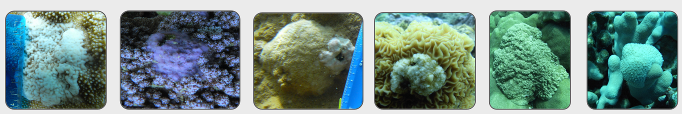
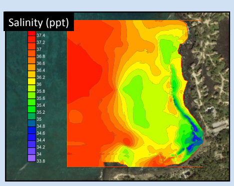
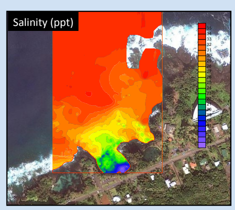


Figure 1. Growth anomaly (GA) on coral species examined on Hawaiʻi Island.

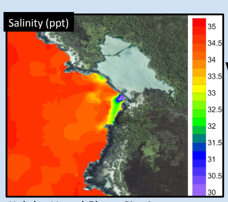
Site descriptions



Kahuwai Bay. This site is influenced by high groundwater discharge, high proximity to industrial development, moderate human traffic, and high coral cover. Map data collected in August 2011



Richardson's Beach Park. Site is influenced by high groundwater discharge, high proximity to residential development, high human traffic, and high coral cover. Map data collected in August 2011



Kaloko Honokōhau. Site is influenced by high groundwater discharge, high proximity to industrial development, high human traffic, and high coral cover. Map data collected in August 2011.

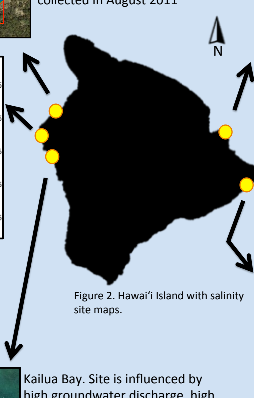
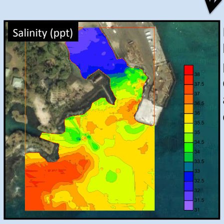
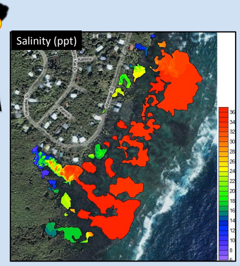


Figure 2. Hawaiʻi Island with salinity site maps.

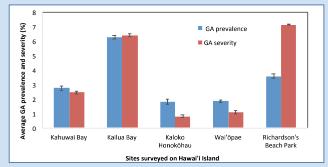


Kailua Bay. Site is influenced by high groundwater discharge, high proximity to industrial development, high human traffic, and high coral cover. Map data collected in August 2011.



Waiʻōpae. Site is influenced by heated groundwater, high proximity to residential development, high human traffic, high coral cover, and various levels of water flow. Map data collected in June 2011.

Results



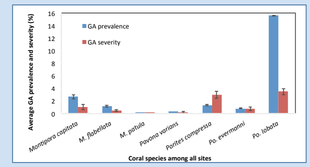
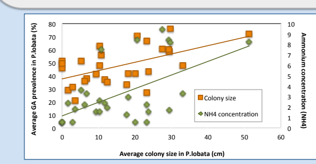


Figure 3. (a)Prevalence (blue) of GAs did not vary among sites, however, severity (red) of GAs was greatest at Richardson's Beach Park. (b) Prevalence and severity of GAs differed among species. Prevalence of GAs was greatest on *Porites lobata* and *Montipora capitata*, however, severity of GAs was greatest on *P. compressa* and *P. lobata*.

GA Prevalence:

- Did not differ among sites (F=1.11, p<0.05) (Figure 3a)
- *Porites lobata* and *Montipora capitata* had the highest prevalence of GA among all coral species studied (F=10.49, p<0.05) (Figure 3b)
- Colony size(cm) and NH$_4$ concentration were the only factors influencing the GA prevalence in *P. lobata* (F=7.36, p=0.003, r^2[adj]=32) (Figure 4a)
- Species density was the only factor influencing the GA prevalence in *M. capitata* (F=23.01, p=0.02, r^2[adj]=84.6) (Figure 4b)



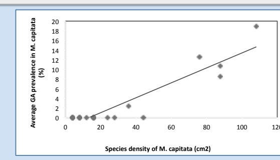
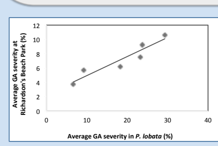
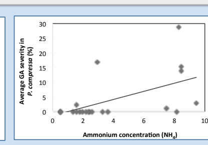


Figure 4. (a)Linear regressions between ammonium concentration (blue), average colony size (red), and prevalence of GAs *in P. lobata*. These were the only factors correlated to GA prevalence in this species. (b) Linear regression between species density and prevalence of GAs in *M. capitata*. This was the only factor correlated to GA prevalence in this species.

GA Severity:

- Richardson's Beach Park had the highest severity of GAs (F=9.21, p<0.01) among all sites (Figure 3a)
- *P. compressa* and *P. lobata* had the highest severity of GA among all species (F=4.71, p=0.001) (Figure 3b)
- Severity of GAs in *P. lobata* was the only factor influencing the overall GA severity at Richardson's Beach Park (F=20.81, p=0.01, r^2[adj]=79.8)(Figure 5a)
- NH$_4$ was the only factor influencing the severity of GA in *P. compressa* (F= 9.96, p=0.004, r^2[adj]=27.2)(Figure 5b)
- Depth was the only factor influencing the severity of GA in *P. lobata* (F= 65.97, p=0.001, r^2[adj]=92.9c)(Figure 5c)





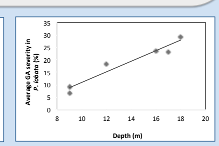


Figure 5. (a)Regression tests showing severity of GAs in *P. lobata* is strongest factor influencing the overall severity of GA at Richardson's, Hilo.(b) Depth(m) was the strongest factor influencing the severity of GA in *P. lobata* at Richardson's. (c) Ammonium (NH$_4$) was the strongest factor influencing severity of GAs in *P. compressa* among all sites.

Conclusion

- No water quality or community structure parameters singularly explained the prevalence and severity of coral growth anomaly (GA) among all species and sites on Hawaiʻi Island.
- Ammonium concentration, colony size, species density, and depth significantly influenced the prevalence and severity of GAs for specific, consistent with previous studies (3,5,6).
- Heterogeneity of GA prevalence and severity among coral species and sites suggests that the epizoology and etiology of this coral disease needs to be examined further in detail.

References

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